THE

ELECTRICAL REVIEW.

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THE

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A NEW PHASE OF COMPETITION.

SOME few months ago English electrical circles were perturbed, perhaps even a little inclined to be angry, because a large order for electric railway plant had gone to America. Consolation was sought from the fact that after all we had no experience of three-phase or quasi three-phase, railway work, and that our American friends were bound to secure at least some of the early contracts. A patriot may be forgiven a feeling of uneasiness when he contemplates the recently-equipped tramway lines, even where three-phase is not employed. Bradford, the most recent addition to English electrical lines, is mainly equipped with American plant, the important system of Middlesbrough and Stockton is American from start to finish, the new tramway at Cork will employ American plant, and more important than all, the extensions to the Leeds tramways will be carried out with materials made in America. We have said sufficient to indicate that the competition of the United States is very real, and has to be reckoned with. Admitting, however, that we had much to learn in tramway work, and that our lesson must be based on American experience, it was not generally supposed we could be ousted in the supplying of lighting machinery. But it is apparent that in the position where we fondly considered ourselves impregnable, we have sustained what appears at first sight to be something like a reverse. It is not surprising that our American friends should have indulged in a good deal of self-congratulation at being called upon to supply extensive lighting plant to the Metropolitan Electric Supply Company, and they may be permitted to enjoy their triumph. It will be remembered that this plant was described and illustrated in our last issue. Is the matter, however, a serious one from an English point of view? It goes without saying that in consequence of this large order going to America, there has been a considerable fluttering in the dovecots of English contractors; but a closer investigation into some of the surrounding circumstances may help to dissipate some erroneous conclusions.

The Metropolitan Company has been criticised by some for going out of the country at all; others, a little more precise in their complaints, have urged that a mistake was made in adopting two-phase plant. With the first of these criticisms it is unnecessary to deal; but the second is a singularly dangerous one to offer, especially on behalf of a contractor.

It might be opportune, though diverging for a moment from the main topic, to refer to the position of the British manufacturer abroad. This country is possessed of a large and honourable corps of Consuls, who, in the main, are ever ready to further British commerce; but if our memory serves us right, the one weakness urged by Consuls against English manufacturers is, that they are not very ready to meet the wishes of potential customers by supplying exactly what they require. The German and American manufacturer, quick to appreciate the wants of a community, will supply just what is wanted, without stopping to inquire whether it is a reasonable or a foolish demand.

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We have cited this example, because it appears to us that we are drifting in a similar direction in electrical work. If a man wants to buy a continuous current machine for a particular purpose, it is very little use criticising his action and endeavouring to persuade him to buy an alternating current machine. The case of the Metropolitan Company is an almost parallel instance. The technical advisers of this company no doubt wanted certain plant for a specific purpose, and, having made up their minds as to their exact requirements, they went into the market to buy. It does not concern us whether they were right or wrong in their ideas; they were buyers, and simply exercised their right of obtaining what they wanted. In other words, the Metropolitan Company, in the expansion of its system, required two-phase machinery, and to obtain it they had to go out of the country. It cannot be supposed for a moment that, if it had been possible to purchase English two-phase machinery, the company would have sent over the seas for it. The action of the Metropolitan Company implies no inferiority to English machinery; the generators that are made in this country will compare with the best the world produces; as to engines, we need say no more than that our strength to-day as a nation is based on the steam motor.

It must not be forgotten that though the Metropolitan Company's contract is an important one, it forms but a small fraction of the electric lighting extensions that are in progress. From all sides we hear that English works are full of orders, and it is an obvious fact, demonstrated from week to week by our Electric Lighting Notes, that contractors are very generally behindhand with the machinery on order. In spite, however, of the general prosperity that prevails among English electrical manufacturers, we think, in view of future developments, it would be wise for them to bear in mind the demand that is likely to arise for a different class of machinery to which we have been hitherto accustomed. If a customer makes up his mind to use two or three-phase plant, it would be better to supply it, than to endeavour to convert him to a continuous or simple alternating frame of mind. Not for a moment do we suggest that there is likely to be any immediate falling off in the demand for the special type of plant that is now being made in English workshops, but the different conditions that may arise in the development of electricity in lighting, in tramways, and general power work, may bring some modification in the design of machinery. It is in anticipating those modifications that the English contractors will best meet the competition from outside. The efforts of our active American *confrères* are not likely to be lessened by recent successes. We must study the reasons of their success and profit by them.

The Value of the Ampere.

A new determination of the ampere, made by a committee of the American Association for the advancement of Science, was announced at their recent meeting. The mechanical equivalent of heat determined by Griffiths, and by Schuster and Gannon, with the electrical method, has given results differing by one part in 400 from Rowland's corrected result. Energy being of the dimensions of $C^2 R$, it was natural to look rather for an error in the determination of the ampere than of the ohm, since a small percentage error in the former would be doubled in the measurement of energy. Moreover, in the determination of the ohm, experimental skill seems to be, for the present, exhausted, and has left no discrepancy of the required order between the results of different observers. A new measurement of the ampere was accordingly undertaken, and stated as before as a relation between the torque of an electro-dynamometer and the weight of silver deposited in a voltameter. The result obtained was ·0011192 gramme of silver per ampere per second, instead of ·001118 gramme, the hitherto accepted figure of Lord Rayleigh, from a certain solution of silver nitrate. For the latter figure Lord Rayleigh claimed no greater accuracy than one part in 1,000. The new result removes the discrepancy between values obtained by the electrical and mechanical methods for the mechanical equivalent of heat, and if it be generally accepted, which we have no reason to doubt, is very satisfactory. Its effect would be to reduce the value of the Clark cell from 1·4342 volt to 1·4327 volt at 15° C, but this is to be the subject of a direct determination. The principal and very important improvement made by the committee in the mode of procedure was the suspension of the dynamometer coil by phosphor-bronze strips instead of by a bifilar suspension. The torsional constants of the bronze strips admit of very exact measurement independently of the dynamometer.

The Specific Heat of Metals at Low Temperatures.

Prof. Trowbridge has published in *Science* (Vol. viii., No. 183, p. 6) the results of some experiments which he has recently made in order to determine the specific heat of metals at low temperatures, which will be found of great value to physicists, for few experiments of this kind have yet been made. He intended to use liquid air for reducing the temperature of the metals employed to a definite number of degrees below zero Centigrade, but finding that when this substance is kept in a state of ebullition it loses its nitrogen and becomes liquid oxygen, he employed this latter element and determined its temperature to $h - 181{\cdot}4°$ C. The ordinary calorimetric method of mixtures was relied upon, but some very elaborate precautions were introduced in order to ensure accuracy. The following results were obtained employing liquid oxygen:—

Metal.	Specific heat −181·4....15° C.
Copper	0·0868
Iron	0·0914
Aluminium	0·1833

By employing boiling water the results obtained were:—

Metal.	Specific heat 23°....100° C.
Copper	0·0940
Iron	0·1162
Aluminium	0·2173

It will be observed that there are considerable differences which expressed actually and by percentage, are as follows:—

Metal.	Actual difference between the two values.	Percentage difference between the two values.
Copper	0·0072	7·6 %
Iron	0·0248	21·3 %
Aluminium	0·0340	15·7 %

By every imaginable means these remarkable results have been tested, and Prof. Trowbridge states that making every allowance for errors of experiment, it seems impossible that these results are otherwise than accurate. If there are errors they would seem to amount to less than 1 per cent. No suggestion is made by the author regarding the significance of these results, and it is not easy to see quite what they mean, but they must have the effect of making us give pause, and will probably result in a considerable modification of our views regarding the physical properties of the metals.

DUFLOS ARC LAMP.

Amongst the appliances that have most taxed the ingenuity of inventors, writes "A. Z." in *L'Industrie Electrique*, the arc lamp undoubtedly occupies a prominent place. The ever-increasing number of patents in this connection shows that the problem is not yet solved, or only imperfectly solved. In brake lamps particularly, which are now being most used and which seemed faultless, we notice in course of time a certain irregularity due to the variation of the coefficient of friction under the influence of dust or damp.

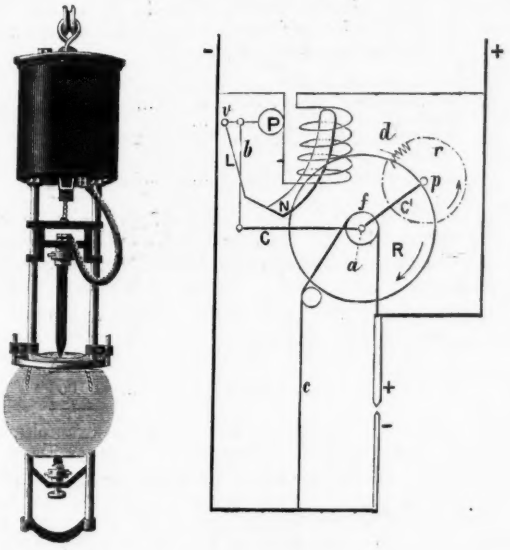
It is with a view to lessening this defect, at the same time ensuring to the lamp a certain and reliable regulation, that the Duflos lamp has been designed, and up to the present it seems to satisfy all the conditions necessary for good working.

In this lamp the regulation is effected by a shunt coil, which, while simplifying the construction, enables greater sensibility to be obtained than in differential lamps.

Description.—The principle of this lamp is as follows:—Two carbon-holders are connected by a Vaucanson chain, *c*, the links of which catch on a pinion mounted on the axle, *a*, of a large toothed wheel, R, and in one piece with it.

A part, C C′, which oscillates freely round the axle, *a*, bears a small pinion, *p*, which catches into the wheel, R, and on the axle of which is fixed a wheel with long teeth, *r*.

A fixed stop, *d*, catches in the teeth of the wheel, *r*. The part C C′, by means of the connecting rod, *b*, and the jointed



lever, L *v* P, which moves round the point, *v*, follows the movements of a laminated soft iron core, N, when it is displaced within a solenoid, B, the winding of which is mounted in shunt on the terminals of the lamp.

A weight, P, balances this arrangement.

Working.—Let us suppose that the two carbons are separated from one another. At the moment when we close the interrupter, as no current is passing through the carbons, the difference of potential at the terminals of the lamp is at its maximum, the intensity of the current passing through the solenoid is also at its maximum, and the iron core is powerfully attracted.

The part C C′ being pulled by the connecting rod, *b*, and the lever, L, turning round the axle, *a*, the part C rises, the part C′ falls, the teeth of the wheel are freed from the stop, *d*, and immediately the wheel, R, turns in the direction of the arrow, drawn by the weight of the positive carbon-holder; the pinion, *p*, and the wheel, *r*, turn in the opposite direction, until the two carbons come in contact. At this moment, the circuit being closed, the difference of potential at the terminals of the lamp suddenly falls, the attraction diminishes in the bobbin, B, and the core, N, falls, the part C C′ swings, the part C′ rises, and one of the teeth of the wheel, *r*, is brought against the stop, *d*, and the wheel, *r*, then ceases to turn; the part C′, continuing its upward movement, draws with it the wheel, R, and makes it turn a little in the opposite direction. This movement has the effect of separating the carbons, and the arc is formed.

As combustion goes on, the distance between the carbons is increased, and also the resistance of the arc, the difference of potential at the terminals also increases, and the core gradually enters the solenoid, drawing with it the part, C C′, and making one of the teeth of the wheel, *r*, slip along the stop until it is freed. The wheel, *r*, being free, turns in the direction indicated by the arrow, the carbons are drawn a little closer together, the core falls a little since the attraction has diminished, and the next tooth catches upon the stop, which holds it fixed. This goes on all the time the lamp is working.

The sticking together of the carbons is in this lamp rendered if not impossible at any rate of very rare occurrence. If any impurity does get in, the gaseous products resulting from it have the effect of lessening the resistance of the arc, which tends to allow a greater intensity to pass through. But as the resistance of the arc diminishes, the difference of potential at the terminals of the lamp also decreases and the core falls, drawing with it the part, C C′, and the wheel, *r*, in the opposite direction to the arrow, which produces a greater separation of the carbons until the arc has attained its normal resistance. At the same time the stop, *d*, catches more firmly into the teeth of the wheel, *r*, which are cut sufficiently deep on purpose.

This separation of the carbons allows a sufficient quantity of air to be introduced into the arc to bring about the total combustion of the impurities which cannot in this case form "knobs."

This sticking together being thus prevented, the working of the Duflos lamp is rendered very reliable and very economical. A simple modification in the number of turns of wire on the solenoid enables the lamp to be worked by an alternating current. Lastly, we may add that by modifying the regulating apparatus the same type of lamp can be made to operate at from 3 to 13 amperes.

A FRENCH VIEW OF ELECTRICAL POWER TRANSMISSION.

Writing in the *Revue Générale des Sciences*, M. Paul Janet would have every workshop, every warehouse, and even every workman's lodging or home provided with necessary power from some central point where such power can be produced under the best and most economical conditions. Other systems of power transmission, by cable, compressed air, water, all have their disadvantages; but the discovery of the reversibility of the dynamo gave a new aspect to the whole question. The efficiency of a transmission is reduced by three losses, which, to give fixity of idea, are set down as 10 per cent. in the generator, 10 per cent. in the receiver, and an amount in the line represented by $p = \frac{R\ P\ r^2}{E^2}$

where R is the line resistance in ohms, P is the power in watts, E the voltage, and *r* is the efficiency of the generator. Thus, with a power of 100 H.P. (French), or, say, 73,600 watts, and 10 ohms of resistance with 4,000 volts, the generator output being 90 per cent., we get the percentage of line loss

$$p = \frac{10 \times 73{,}600 \times 0{\cdot}81}{16{,}000{,}000} = 3{\cdot}7 \text{ per cent.} \quad (1)$$

Hence the necessity of high voltage and small line resistance. The upper limit of the tension depends upon the possible difficulties in insulation of machines and of the line itself, difficulties which increase more rapidly than the tension itself. Losses from line are of two kinds, conductive and disruptive. The first are due to poor insulating material, and are most serious, being invisible, silent, and resembling the leakage of water from porous pipes. Damp air is the chief cause of such losses, or moisture on the line supports.

Disruptive losses may occur, no matter how dry the air, or how perfect the insulation, with a high tension. Disruptive discharges resemble the sudden rupture of a very impermeable water pipe, hard but fragile. There is a sort of electric fragileness. The subject was once looked on as rather in the domain of static electricity, and no fear was felt of disruptive discharges in the use of currents, but to-day electricians begin to encounter phenomena hitherto hardly seen outside the laboratory. Hence the necessity of limiting tension to about 20,000 volts. Line resistance can be diminished at will by increase of section. If d is the length in kilometres between two stations, the weight in *tonnes* of the two conductors will be

$$W = \frac{0{\cdot}7\ d^2}{R}. \qquad (2)$$

Thus for 10 kilometres and 10 ohms total line resistance the weight will be $\frac{0{\cdot}7 \times 100}{10} = 7$ tonnes, which at 2,000 francs per tonne (£80) will make the line cost £560. Combining the two foregoing formulæ, it is found that

$$W = \frac{0\ 7\ d^2\ P\ r^2}{p\ E^2}. \qquad (3)$$

Thus for a given distance, power, and voltage, the weight, and, therefore, the cost of a line varies inversely to the loss allowed, a heavy loss allowing an economy of copper, while a large locked up capital in copper will reduce the line loss; hence Kelvin's law that "for a maximum economy it is necessary that the cost of the energy annually lost in the form of heating of the line should be equal to the interest and amortisation charges of the capital represented by the copper in the line." The energy lost per second in the line is equal to $R\ I^2$ by Joule's law, I being the ampereage of the current. The cost of the energy lost annually is thus proportionate to $R\ I^2$, and may be represented as $k\ R\ I^2$. The weight, and therefore cost of line is proportionate to $\frac{d^2}{R}$. Hence interest and sinking fund must be $k'\frac{d^2}{R}$. Applying Kelvin's law, we have in $k\ R\ I^2 = k'\frac{d^2}{R}$, whence $R\ I = \sqrt{\frac{k'}{k}}\ d$. But the resistance of a line depends on its length, and is inversely as its cross section; thus $R = k''\frac{d}{s}$; whence $\frac{I}{s} = \frac{I}{k''}\sqrt{\frac{k'}{k}} = \text{const.}$

Kelvin's law thus leads up to the remarkable result that "to obtain the best conditions and most economical, the quotient of the current intensity by the line section—*i.e.*, the amperes per square centimetre—should have a value depending on the price of copper and of mechanical power, and on interest and sinking fund, but altogether independent of distance. The complete formula for current density is $\frac{I}{s} = \frac{1}{40}\sqrt{\frac{0\ 7\ a\ a}{100\ p\ N}}$, where a is the price of copper per ton (in francs) a is the interest, &c.; p, the price per watt-hour; N, the annual number of working hours. Thus, to take a concrete example, as at Niagara, with copper at 1,350 francs, and interest at 5 per cent., and the price of a H.P. per year 75 francs, the best current density will be found to be about 55 amperes per cm².

The principal elements of a transmission scheme are now easy to calculate. Choosing the tension as high as possible, the line current intensity is immediately deduced, since the product of the intensity by the tension to the power transmitted is to the output of the generator.

Kelvin's law then gives the best density to adopt, and there is obtained immediately the section of the line and its weight. These elements fixed enable the costs to be approximately established.

It is not possible to fix, exactly, the price of machines. They may be set down at 100 to 150 francs per kilowatt (£4 to £6). This enables the cost of generators to be given, while the small economy due to line loss need not be taken into account in calculating the motors in a first calculation.

For the line, copper of highest conductivity should be employed, and cost may be calculated at once from the market price, which will be higher than that of ordinary copper. To this must be added the pole cost, and insulators, posts being spaced at 50 m. apart, and valued at 25 francs each, with their insulators (£1). Thus a kilometre will cost 500 francs (£20).

Thus, to transmit 200 H.P. to 10 kilometres at 4,000 volts, with, say, 10 per cent. loss at the generator, 7½ per cent. at the motor, and 12½ per cent. in the line, or a total loss of 30 per cent. (the losses are given all in terms of the motive power), the line must weigh $\frac{0{\cdot}7 \times 100 \times 200 \times 736 \times 0{\cdot}81}{0{\cdot}125 \times 16{,}000{,}000}$ = 4·17 tonnes by the formula (3), which, at a cost of £80 per tonne, will amount to £334, while the poles, &c., will cost £200, making a total of £534.* The generator will cost, at £4 per kilowatt, £588, and, neglecting the small economy of the smaller motor, this may be set down at the same price, or a total for the two machines of £1,176, or a total for machines and lines of £1,710, to which 5 per cent. may be added for apparatus, making a total of £1,795 for the mere electric plant. For this there will be delivered 140 H.P. at the motor terminals; the cost is thus nearly £13 per H.P. The cost of the same installation at only 1,000 volts would be about £48 per H.P. delivered, which is sufficient to show the extreme importance of the highest possible voltage.

At first sight the advantage of transmitting a water-power lies in the fact that the power costs nothing. Nevertheless, with possession of a water-power goes the necessity of constructing dams, channels, gates, tunnels, turbine houses, &c., all which when set down as capital at an annual charge for interest and depreciation may represent an expense comparable with the cost of fuel. A few examples are given from actual practice. No. 1. A fall of 100 metres and 4,000 litres per second in the Département de l'Hérc. Power utilised 4,000 H.P.

The fall cost to acquire	£12,000
Dam, canal, and pipes	10,000
Buildings and foundations	2,000
20 turbines of 200 H.P. each	3,200
Total	£27,200

The cost of power is thus nearly £7 per H.P. at the turbine shafts. In the Dpt. du Jura a fall of 2 metres, with 15,000 litres per second and 300 H.P. utilised, cost as follows:—

Water rights	£1,800
Canal and building	6,000
Three turbines, each 100 H.P.	1,200
Total	£9,000

or £30 per H.P. at turbine shafts. These two examples are chosen as being particularly characteristic of extremes of high and low fall, and at once is seen the great benefit of using the maximum fall reasonably to be secured. In fact, nothing is so remarkable as the small size of turbines and plant necessary to utilise water at a high pressure. Of the first class of high falls may be cited the paper mills at Lancey, near Grenoble, where a fall of 500 m. has been utilised, while of the second kind the low falls of the Rhone, at Geneva, show what heavy work is necessary to utilise large masses of water at low falls.

Again, in Upper Savoy, a fall of 140 metres, giving a mean flow of 8,000 litres per second, and never falling below 4,000 litres, has been utilised. For three-fourths of the year some 11,000 H.P. is available, and in winter about 6,000 H.P. The value of this fall is estimated at £12,000, the work of installation at £20,000, including gates, dams, tunnels (one of 600, one of 650 metres in length), 2 m. high and 2·5 m. wide, canal, two steel pipes 1·40 m. diameter, and 500 m. long. Adding the turbine cost, say, £440, gives a total of £36,400 for 11,000 H.P., or only £3·32 per H.P.

In comparison with steam-power, the author gives an estimate as follows for 100 H.P.:—

Engine	£800
Boiler, &c.	800
Building, &c.	400
Total ...	£2,000, or £20 per H.P.

* 25 francs are translated as £1.

The price of the engine seems high; the present writer would be glad to sell first-class steam engine power at little over half the above figure.

For a 300-H.P. engine the cost is thus set down:—

Engine	£2,000	
Boiler, &c.	2,000	
Buildings, &c.	800	
Total ...	£4,800, or £16 per H.P.	

while a third estimate for 1,000 H.P. is:—

Engine	£4,000	
Boiler, &c.	6,000	
Buildings	2,000	
Total ...	£12,000, or £12 per H.P.	

Even at half the foregoing estimates the cost of steam plant appears higher than the cost of high fall water-power, in addition to which there is also to be added the continual expense in fuel, wages, &c., and if the power is used for many hours, water-power has the advantage, while, for short working hours, steam may sometimes be better placed. The figures seem to us to indicate that the French are better hydraulic than steam engineers, and able to do more with a given sum than when they set out to instal steam plant. To pay £6,000 for boilers to give 1,000 H.P. in economical engines seems to us very high pricing.

Taking the case of 140 H.P. at the point of application, a hypothetical case is supposed at 4,000 volts, the water-power being of the high-fall type, and the utilisation day and night for 8,760 hours. The cost will then be:—

For electric installation	£1,791
Hydraulic plant, 200 H.P. at 170 francs ...	1,360
Total	£3,151
Interest, &c., at 10 per cent. ...	315

This is the annual cost. The same power from steam is given as follows:—

140 H.P. at £20	£2 800
Interest at 10 per cent.	£280
Total H.P.-hours	1,226,400
Tons of coal burned	1,230
Cost at 30 francs per ton	£1,476
Total annual cost	£1,756

The coal is dear at 30 francs (24s.), and this item might be reduced anywhere down to a fifth, and the total cost would then be about £580 annually, but even this is far above the cost of water-power.

Taking the voltage at 1,000 and a low fall and a utilisation of 3,000 hours annually, the annual charge of 10 per cent. on the installation for the same power at the rate of £30 per H.P. will come out as £1,273, while the cost of the steam-power will be as before £280 for interest and only £504 for coal, or £784 annually. Even with such dear fuel the steam now comes very much cheaper than water-power. It is thus important to seek high falls, high tensions, dear coal, and long hours in a proposed water-power with electrical transmission, while the reverse data favour the application of steam-power.

The figures presented by M. Janet are by no means favourably chosen for steam-power. It is obvious, therefore, that coal-using countries are not likely to be so easily run off the road as loose thinkers are so apt to make out.

In discussing the system of transmission to be employed, there is but one alternative; direct or alternating currents alone are available; the first-named have the advantage of age, having been those of the Gramme machine. A dynamo may be constructed for all speeds, tensions, intensities, and other properties, so long as these are properly balanced; but for continuous current machines, there remains the difficulty of insulation at high tensions. This difficulty comes in at the commutator. This becomes so multiple in its bars at high tension, that difficulties arise in construction. Without going into details, it may be said that currents of 3,000 to 4,000 volts work all right, and they may be coupled so as to add to this tension, and partisans of continuous current are still numerous, despite the brilliant success of alternating current, and would not hesitate at continuous transmission even at 20,000 volts. But the author believes that the current of to-day is the alternating. Simpler machines produce it; the commutator is absent. Transformers are applicable for raising the tension to any desired amount—apparatus without a moving part.

With all advantages, however, the alternating current has also its disadvantages. While the motors are also simplified, they present difficulties in starting not yet surmounted. Though very well for regular work at full power with few stoppages, the alternating current must still give way to direct current for opposite conditions. This difficulty however, appears likely to be swept away by the discovery of the polyphase alternating machines. Equally available for high tension, they have the general advantages of continuous currents, and in respect of starting of motors are but little in arrear of the latter. They have the further advantage of diminishing the weight of line necessary. Without going into detail, it may be said that tri-phase machines have three terminals in place of the two we are accustomed to find in all electrical appliances—three lines in place of two. Thus, if E be the tension between any two terminals, I the current in the line, it can be shown that the power carried under these conditions is $P = E I \sqrt{3}$. If R is the resistance of one line, the power lost in the line is $3 R I^2$. With two-line transmission to carry the same power at equal tension, $P = E I'$ where $I' = I \sqrt{3}$. Let R′ be the resistance of one of the two lines, then the power lost will be $2 R' I'^2 = 6 R' I^2$. If we desire the loss in each case to be the same, then must $3 R I^2 = 6 R' I^2$, whence $R = 2 R'$, from which it directly follows that with tri-phase current the cross section of each line will be of half the area needed for ordinary current. If p is the weight of one line of tri-phase the total weight of line for tri-phase current is $3 p$, and for ordinary current, $4 p$, thus securing an economy of 25 per cent. All this demands that the introduction of polyphase current should be considered as one of the greatest steps in modern electrical industry—and, in fact, most large installations are based on polyphase working. Yet continuous current will never lose its advantages, and will always be used for certain special cases; but it seems that simple alternating current ought to be excluded from new installations. This has been a little forgotten of late.

The author concludes that the exhibition of 1900 will afford a chance of studying all systems on a grand scale. We should add that the author of the interesting article we have abstracted as above is M. Paul Janet of l'Ecole Superieure d'Electricité.

SOME NOTES ON THE ELECTRO-DEPOSITION OF CHROMIUM.

By SHERARD COWPER COLES.

Chromium is not a very common substance; it does not occur in the free state, being generally found as an oxide, its lower oxide closely resembling that of iron, Cr O and $C_2 O_3$. Chromium forms the colouring matter of several compounds; for instance, the green colour of the emerald, as was shown by Vauquelin; serpentine, also, owes its colour to chromium. Some of the characteristics of chromium are its great hardness and its high melting point, it being more difficult to fuse than platinum, the temperature required being 2,000° F.

Chromium stands tarnishing effects of the atmosphere, and is little affected by nitric acid, even when hot and concentrated, pure chromium oxidising very slowly in hot air, but, on heating the surface, it becomes readily covered with a thin film of oxide; dilute sulphuric acid only attacks it slowly.

Prof. Hittorf found that chromium in dilute acid solutions in the cold causes hydrogen to be given off, but that chromium is electro-negative to such metals as copper, mercury, and silver. In the same way it fails to reduce such metals from solutions of their neutral salts, and behaves generally as an inert noble metal. On making chromium an anode in cold dilute acids, it dissolves, but not with the formation of chromous or chromic salts, it passes at once into the state of chromic acid. The results of the experiments carried out by Prof. Hittorf are thus summarised by him:—Chromium can dissolve electrolytically

in any one of its three states, CrO, Cr_2O_3, or CrO_3; according to the nature of the electrolyte and its temperature, its inactive state corresponding, perhaps, with the passive state of iron. The attainment of this passive state is not to be attributed to the presence on the metal of a thin layer of oxide, the hypothesis which is plausible for iron. It appears rather to imply that the surface, at least, of the metal differs in molecular arrangement according to the conditions and surroundings to which it is exposed; in short, that chromium appears to be an allotropic element. Chromium exists in three different states, viz., passive, active, and intermediate, and in each of these states it occupies a different position in the electro-chemical series and possesses a different chemical behaviour.

Metallic chromium has been obtained by the reduction of oxides and chlorides. Deville made a mixture of chromic oxides and sugar which he intensely heated in a lime crucible, or heated chromium sesqui-chloride, with metallic zinc under a layer of sodium chloride, the zinc regulus was treated with nitric acid, when metallic chromium remained behind as a grey powder.

Chromium has also been obtained by electrolysing chromous chloride, containing chromic chloride, the metal separating out in glistening scales.

A method of preparing chromium in the electric furnace has been devised by Herr Eschermann, in which a gas-tight steel furnace is used in connection with a movable electrode. A graphite crucible is placed in the furnace, and in this are placed oxide of chromium and sulphide of antimony, in the proportion of 10 to 23. After the furnace is closed a comparatively small current of from 20 to 23 amperes is passed through the material until melted. Reaction takes place with the development of heat. The resulting mass consists of a regulus of chromium and antimony alloys, whilst the upper part of the crucible has an amorphous mass of antimony oxide, sulphide, &c., adhering to the walls. Every trace of antimony can be removed by repeated meltings, or by powdering and roasting at a white heat. The chromium dissolves a considerable portion of carbon, which separates out as graphite during cooling.

Metallic chromium has lately been obtained in considerable quantities by Dr. Hans Goldsmidt and Claude Vautin by reducing chromium oxide (Cr_2O_3) with aluminium in a fine state of division, the heat of combination being used for reducing the chromium oxide, the action being started by a small fuse or cartridge composed of peroxide of barium or other suitable per salt, which is fired by a piece of magnesium ribbon to start the reaction. Pure chromium is being made by an electrolytic process by the Elektro-chemischen Werke, Bitterfield, Saxony. Chromium is being sold in Germany at the following prices:—Free from carbon, but containing some iron and traces of silica, 15s. a pound. Chromium free from carbon, and containing 96 per cent. chromium, and 3 to 4 per cent. iron, and traces of silica, at 4s. a pound.

Fused chromium is quoted on the American metal market at $7.14 per K.G., and commercial pure powder at $1.90.

Chromium carbide has been produced by Henri Moissan, the composition being Cr_3C_2 or Cr_4C. Chromium carbide is not acted upon by water; it forms an opaque crystalline mass with a metallic lustre.

Some attention seems to have been recently given to the electro-deposition of chromium from aqueous solutions. The process of Placet Barnet has been worked on a commercial scale. According to the patent specification, the electrolyte is made up by dissolving 100 parts of chromic alum in 100 parts water by weight, 10 to 15 of barium bisulphate. The writer has obtained lustrous dark deposits from this electrolyte when worked at a temperature of about 200° F. with a platinum anode, the current density being about 5 amperes per square foot, and the voltage at the terminals of the cell being about 4.

Bunsen experimented with the deposition of chromium, and succeeded in getting a good deposit of metal, which had the appearance of iron, but was less alterable in moist air, and even resisted the action of boiling nitric acid, but was acted upon by dilute sulphuric acid and HCl.

E. Placet claims to have obtained beautiful deposits of chromium by electrolysing an aqueous solution of chromic alum, to which he added an alkaline sulphate and a small quantity of sulphuric acid.

The electro-refining of chromium has been tried by the firm of Messrs. Fred. Krupp, Essen, the object being to produce chromium free from carbon, no precautions being taken to prevent the production of a metal containing iron or ferro-chromium. Double chlorides of the metals are used as an electrolyte, the anodes being of ordinary carbonised ferro-chromium, porous diaphragms being used to separate the anode and cathode compartments.

Attempts have been made to deposit chromium alloys, and a patent was obtained in March, 1884. Alloys of chromium were prepared by heating chromium compounds with charcoal in a closed crucible, and pouring upon the reduced mass 2½ parts of copper and subsequently from 1 to 1½ parts of molten tin, and then granulating, re-fusing, and casting in moulds of the desired forms. The plates thus formed were used as anodes in a solution made by dissolving 1 lb. of cyanide of potassium and 1 lb. of carbonate of ammonia in 1 gallon of water heated to 150° F., until a good deposit was obtained upon the cathode, a low current density being employed.

When a solution of chromium chloride is electrolysed with a negative electrode of mercury, the mercury is found to take up but little chromium, a brownish-black chromium oxide being formed in the liquor. T. Féreé has used with mercury a solution composed of 160 grms. of crystallised chromium chloride, with 100 grms. of concentrated hydrochloric acid, and 740 grms. of water, with a current of 22 amperes. In this way he found it possible to obtain 1½ kilos. of solid chromium amalgam in a very short time.

The following table gives the comparative hardness of electro-deposited chromium, as represented by the number of grammes weight on a diamond point, required to produce a scratch:—

	Hardness.
Nickel electro-plate	10·0
Sheffield plate	10 0
Antimony electro-plate	9 0
Palladium (deposited bright)	9 0
Chromium deposited on copper	7·0
Palladium electro-plate	6·6
Cadmium silver alloy, 5 Ag., 39 5	5 0
Cadmium deposited bright	4 5
Silver (burnished)	4·0

ELECTROSTATIC CAPACITY OF WIRES.

By W. MOON.

In electrostatic units the capacity of two coaxial cylinders is

$$\frac{l}{2 \log. \frac{R}{r}}, \qquad (1)$$

and the capacity between a wire and an infinite plane

$$\frac{l}{2 \log. \frac{4D}{d}}, \qquad (2)$$

and that between two isolated wires is

$$\frac{l}{2 \log. \frac{4D^2}{d_1 d_2}}. \qquad (3)$$

If $d_1 = d_2$, formula (3) becomes

$$\frac{l}{2 \times 2 \log. \frac{2D}{d}}, \qquad (4)$$

where "d" is the diameter of the wires and "D" their distance apart.

Formula (1) can be written

$$\frac{l}{2 \log. \frac{2D}{d}}, \qquad (5)$$

where "D" is the radius of the outside cylinder and "d" the diameter of the inside cylinder, that is of a wire.

If "v," the ratio of the electrostatic to the electro-magnetic units, is taken as 3×10^{10}, then the preceding formulæ are reduced to electro-magnetic C.G.S. units by dividing by

$v^2 = 9 \times 10^{20}$. And since there are 10^{15} C.G.S. units in a microfarad, these formulæ are reduced to microfarads by multiplying them by

$$\frac{10^{15}}{9 \times 10^{20}} = \frac{1}{9 \times 10^5}$$

And, further, if l is taken in miles = 160,931 centimetres, and common logs. are used, formulæ (2), (4) and (5) become

$$\frac{l \cdot 03883}{\log. \frac{4\,D}{d}}, \qquad (6)$$

$$\frac{l \cdot 03883}{2 \log. \frac{2\,D}{d}}, \qquad (7)$$

$$\frac{l \cdot 03883}{\log. \frac{2\,D}{d}}, \qquad (8)$$

where formula (6) gives the capacity in microfarads of a mile of wire of diameter "d" suspended at a distance, D, from the earth.

Formula (7) gives the capacity between two wires of the same diameter entirely isolated from and other wires or the earth. It is important to bear in mind that this formula no longer applies when the two wires are in the presence of any other conductors, unless their distance apart is exceedingly small as compared with their distance from the other conductors. Formula (7) is not of itself, therefore, generally of use.

Formula (8) gives the capacity of a cable if, of course, it is multiplied by the specific inductive capacity of the dielectric.

From formula (7) and (8) it will be seen that the capacity of two isolated wires of diameter "d" and distance apart "D," is but half that of one wire entirely surrounded by a cylinder of radius "D." And it therefore follows that the capacity "K_{aa}" between a wire, "a," and a number of other wires and the earth, cannot be as great as twice the capacity, K^1_{ab}, between "a" and the nearest wire "b," if the two wires are of the same diameter, "d," and are entirely isolated.

In the case of a number of aerial wires on poles, probably the capacity, K_{aa}, between "a" and the remaining wires and earth is not as great as that between "a" and an infinite plane at the distance of the nearest wire.

It is furthermore evident from formulæ (6) and (7) that two wires would have to be nearly in contact before their capacity as isolated wires was equal to that between either wire and the earth. And, therefore, the capacity between one wire and any system of wires and the earth, could in no case be as great as twice the capacity between one wire and the earth.

Although it would be difficult to calculate the capacity between one wire and a number of other wires and the earth, yet it is evident that there are certain well defined limits between which this capacity must lie, and it is not difficult to assign probable average values to the capacities of any such wires.

In the case of a number of wires on poles, the capacity, K_{aa}, of any one of them with the remaining wires and the earth is not much affected by the position the wire occupies on the poles. But the capacity, K_{ab}, between any two wires is both affected by their distance apart and by their position with respect to the other wires. When the value, K_{aa}, is known, it is not difficult to calculate the probable value of K_{ab} in any particular case.

Since the capacity of one wire of diameter, "d," surrounded by a cylinder of radius, "D," is but twice that of two isolated wires of diameter, "d," at a distance "D" apart, it follows that the capacity, K_{aa}, of a wire, "A," entirely surrounded by wires at a distance, "D," is less than twice the capacity of two isolated wires at the same distance. But since the charge on "a" is divided between a number of wires, the charge that each will take will be small, and therefore the capacity between "a" and "b" will be

$$K_{ab} = \frac{K_{aa}\, d}{2\pi D}.$$

This is the minimum capacity between the two nearest wires on the poles.

When the other wires do not entirely surround "a," each will take a charge proportional to the square of its distance, and the whole charge given to the earth would be proportional to $\frac{\pi}{D}$, so that the capacity between "a" and "b" would be

$$K_{ab} = \frac{K_{aa} \frac{d}{D^2}}{\frac{\pi}{D} + \Sigma \frac{d}{D^2}}.$$

Applying the last formula to telephone circuits rotating in foot squares

$$K_{ab} = \frac{K_{aa} \frac{d}{288}}{\frac{\pi}{226} + d \Sigma \frac{1}{D^2}}$$

$$= \frac{K_{aa}\, d}{4 + 2\, d \Sigma \frac{1}{D^2}}$$

if "D" is taken in feet.

On poles with 28 wires $\Sigma \frac{1}{D^2}$ would vary between 3·8 and 7·2; taking an average value of, say, 5.

$$K_{ab} = \frac{K_{aa}\, d}{4 + \omega\, d} = \frac{K_{aa}}{\omega + \frac{4}{d}}$$

with only two wires on the poles.

$$K_{ab} = \frac{K_{aa}}{1 + \frac{4}{d}}.$$

This is the maximum value of K_{ab}.

It will be seen that this capacity between two wires is small, lying, in fact, in practice, between $\frac{1}{30}$th and $\frac{1}{20}$th of the capacity of one wire with the remainder and the earth.

The charge that any wire "a" takes is

$$q_a = V_a K_{aa} + V_b K_{ab} + V_c K_{ac} + \ldots . \&c.,$$

where V_a is the potential at "a," and K_{aa} the capacity between "a" and the remaining wires, and earth = V_b is the potential of "b," and K_{ab} the capacity between "a" and "b," V_c is the potential of "c," and K_{ac} the capacity between "a" and "c."

Weight of wire per mile.	d	Two isolated wires.			One wire and earth.				Average capacity of one wire and earth.	K_{aa} average capacity of one wire and the remainder plus earth.	K_{ab} average capacity between two wires of a loop.	K eff. average capacity of one wire of a looped circuit.
		D = 12.	D = 17.	D = 60.	D = 12.	D = 17.	D = 60.	D = 240.				
100 lbs.	·079	·0077	0074	·0061	·014	·0133	·0112	00955	·0101	·0125	·0002	·0127
200 lbs.	·112	·00835	0078	·0064	·0147	·014	0117	0099	·0105	·0132	·00029	·0135
400 lbs.	·158	·0089	·00835	00675	·0157	·0147	·0122	0103	·0109	·0141	·0004	·0145
800 lbs.	·224	·00955	·0089	0071	0167	·0157	0128	·0107	·0113	·015	·00054	·0155

Considering only the two wires of a looped circuit

$$q_a = V_a K_{aa} + V_b K_{ab}$$
$$q_b = V_b K_{bb} + V_a K_{ba}.$$

But $K_{aa} = K_{bb}$ and $K_{ab} = K_{ba}$, so that the charges on each wire would be equal if $V_a = V_b$. But in a perfect looped circuit the potential will be zero at the distant end, and also in the middle of the source of the E.M.F., so that the loop may be regarded as two separate wires, each actuated by half the E.M.F. of the circuit, and therefore, $V_a = V_b$, and

$$q_a = V_a (K_{aa} + K_{ab})$$
$$\frac{q_a}{V_a} = K_{aa} + K_{ab} = K \text{ eff.}$$

That is the effective capacity of one wire of a perfect looped circuit may be taken as the sum of the capacity of either wire with the remainder and earth, and the capacity between the two wires of the loop.

In any calculations relating to perfect telephone looped circuits one wire only of the loop should be taken, and it should be assumed that this wire is actuated by half the E.M.F. of the circuit. And the "effective capacity" given in the last formula should be taken as the capacity of the wire.

The table on p. 479 giving the capacity in microfarads of a mile of wire will serve to illustrate this paper; "*d*" and "D" are in inches, and the four copper wires are of gauges giving 100, 200, 400, and 800 lbs. weight of wire per mile.

SIDE LIGHTS ON CABLE ROUTES.

II.

We have laid before our readers as concisely as may be, the story of the futile attempts made by the allied companies (the Eastern, Eastern Extension, and Eastern and South African Telegraph Companies) to confirm their monopolies, and to relieve themselves from the impending danger of competition—at the expense of the nation; we have shown how this very prosperous clique has failed in this endeavour, in spite of the sympathetic interests which they have generally managed to inspire amongst a certain class of officials. We omitted, however, to sufficiently emphasise the fact that in the letter to the Chancellor of the Exchequer, dated November 12th, 1897, and in which the Marquis of Tweeddale leaves in abeyance the prolongation of the cable beyond the Cape, to Australia, the clause intended to quash competition is left unchanged. If this clause had been acceded to, it would have prevented the Government from assisting by subsidy anyone who might desire to compete, on equal terms, with these already subsidised companies in either Africa, India, China, or Australasia. This absurd request was summarily dismissed in the draft instructions to the Departmental Committee.

Perhaps that portion of the scheme on which we are trying to throw light, which relates particularly to the Eastern Extension Company, is the most interesting. We refer to the suggested prolongation of this cable from the Cape to Australia, which is now for convenience put into the background. We have frequently drawn attention to the delays and interruptions which occur on the Australian landlines, and find support for the views we have so often expressed, in a letter, dated February 25th last, addressed to the Chancellor of the Exchequer by Mr. J. Denison Pender, who, as a director of the Eastern Extension Company, writes with full knowledge of the subject. Mr. Pender, in the course of his letter, writes: "I have the honour to inform you that in consequence of the recent unsatisfactory working of the Australian Government landlines (over which the company have no control) serious complaints have arisen both on this side and in the colonies, and deputations from chambers of commerce and other public bodies have waited on the Postmasters-General of New South Wales and Victoria with a view to ventilating the question and endeavouring to find an effectual remedy.

"The Eastern Extension Company's cables to Australia are landed at Port Darwin in the northern territory of South Australia and Roebuck Bay on the north coast of Western Australia, whence landlines belonging to and worked by the Governments of South and Western Australia carry the telegrams to Adelaide. The bulk of the traffic is transmitted by the Port Darwin-Adelaide landline, the long coast line from Roebuck Bay to Adelaide being more or less unreliable. The proposed Cape-Australian cable, by landing at Perth, would cut out the most defective portion of this line, and consequently much shorten and improve the communication. It is, however, contended that the line between Perth and Adelaide, passing, as it does, through a sparsely populated country, would be liable to as much interruption as the Port Darwin-Adelaide line, and to meet this objection the Eastern Extension Company has intimated to the colonies its readiness to extend the proposed cable from Keeling or Perth to Albany, and thence lay a separate cable to Adelaide, thus making the new connection altogether independent of the long landlines complained of." In return for this extension, which will have the effect of seriously decreasing the revenue of the landlines of South and Western Australia, "the company would require the Australasian colonies to continue the existing subsidy of £32,400 per annum for another 20 years, or 10 years longer than the period named in the original proposal." That these landlines are very long, and very bad, no one but an interested colonial Postmaster-general would venture to deny. We have on a previous occasion pointed out that a telegram sent over the landline from Roebuck Bay to Burketown, in Queensland, would (assuming that it ever reached its destination) have to travel over a length of landline greater than the distance between London and Calcutta, or several hundreds of miles more than the distance intervening between London and Vancouver. The admission made by Mr. Pender as to the landline from Roebuck Bay being "more or less unreliable," is only in accordance with the statement made by Mr. Playford, the Agent-General of South Australia, at the Conference held in Ottawa. This unsatisfactory condition of affairs proves that the cable which was laid from Java to Roebuck Bay in 1889 cannot be looked upon as an alternative to the two cables which run from the same point in Java, to Port Darwin, although it was laid with the intention of assuring communication with Australasia when the Port Darwin cables were broken down.

The Australian colonies, however, do not see the position in the same light as the associated companies, and at the Postal and Telegraphic Conference held in Tasmania in March-April last, at which all the colonies were represented, when the original scheme of the allied companies was discussed, the two following resolutions were passed:—

"That, in the absence of any satisfactory proposal from the Eastern Extension Telegraph Company, and of any proposal at all except on the basis of an alternative cable *viâ* Africa, this Conference is unable to make any fresh arrangements with that company." Also, "That this Conference re-affirms the opinion that in the interests of Australasia the Pacific cable project should be consummated as speedily as practicable, and that the Governments of the various Australasian colonies be requested to represent to the Imperial and Dominion Governments the foregoing opinion, together with the proposal of the premiers, as agreed to at their recent Conference held in Melbourne, viz., 'That if Great Britain and Canada would each contribute one-third of the cost, the colonies would be prepared to contribute the remaining one-third.'"

In the course of this discussion much dissatisfaction was expressed at the unwillingness of the above-mentioned company to meet the colonies, even to the extent of replying to the plain questions put to them as to arrangements consequent on the approaching expiry of the annual subsidy of £32,400 at present paid to the company by the colonies. In the course of his remarks the Hon. Mr. J. Gavan Duffy said that "They had spoon-fed the company, and the more they fed it the more spoon-fed it wanted to be." A strong feeling in favour of an alternative cable *viâ* the Pacific to Canada was also shown, and in reference to this Mr. Gavan Duffy said: "That project was entertained very fairly, and at one time it seemed as though the line would be immediately constructed. But for some reason or other a blight had come over it, and they did not now hear of it." The cause of this "blight" will bear some examination.

In the first place, it is only right to give the allied companies credit for the manner in which they have so long,

and heretofore so successfully, managed to delay the establishment of a competing cable across the Pacific. It is no more than natural that the Eastern Extension Company should strongly object to the lapsing of subsidies, and to the loss of about 50 per cent. of the revenue which they now derive from Australasian traffic, which in 1897 amounted to a total of some £530,000. With this position in view, it is easy to understand the opinion expressed by Sir Sandford Fleming, who, in his very temperate report to the Canadian Government on the evidence given in the Colonial Office before the Pacific Cable Commission at the end of 1896,* expresses himself as follows in reference to this company:—

"It may indeed be held that the company has always assumed an attitude of hostility to the aspirations of Canada in respect to the proposed cable, and have for years strenuously opposed all efforts to advance her own and Imperial interests on the Pacific in connection with the union of Australasia and British North America telegraphically. Be that as it may, I can only repeat the view I have often expressed, that if the exigencies of the Empire, as a whole, demand the establishment of a national work which will interfere with the operations of this private company, every reasonable consideration should be extended to that company by those upon whom it has just claims. But it cannot be supposed that the public interests must be entirely set aside in order that the company may for ever continue to receive large dividends. I will again refer to the position of the Eastern Extension Company, and suggest a means by which, as it appears to me, the matter can be adjusted in the spirit of justice and fairness."

Sir Sandford Fleming also points out that "All doubts as to the practicability of laying an electric cable from the western coast of Canada to the Australasian colonies, touching only on islands in the possession of Great Britain, is now entirely set at rest. The best authorities known were examined, and not one of them expressed the least misgiving on this point."

In this report reference is also made to what has been one of the most serious causes of obstruction in the progress of the Pacific cable project. Sir Sandford Fleming writes: "I have pointed out in what respect there is a general agreement in the views expressed by the several gentlemen examined by the Committee. I shall now refer to an extraordinary diversity of opinion. In this diversity I find ranged on one side the agents the Eastern Extension Telegraph Company and two officers of the Post Office Department. On the other side, all the highest authorities on electrical science, together with the managers of two important ocean cables, whose evidence was submitted to the Committee.

"The two officers were Mr. J. C. Lamb, secretary, and Mr. W. H. Preece, engineer-in-chief and electrician to the General Post Office, London. Their evidence in the main agrees with that of the gentlemen who appeared on behalf of the Eastern Extension Telegraph Company, whose views are adverse to the establishment of the proposed Pacific cable.

"The antagonistic evidence is voluminous. If examined, it will be seen that the gentlemen who submitted it are substantially of one mind on many subjects. The tone and substance of their observations leaves the impression that they do not look upon the Pacific cable as a necessary or desirable undertaking, and that if established as designed, it would be inadequate in capacity and a heavy burden on the public exchequer. I could not venture (here) to take up the time necessary to refute the whole evidence."

Apparently these remarks are principally intended to apply to the preposterous estimate which is contained in a report dated July 5th, 1893, published in the *Proceedings* of the Ottawa Conference. Concerning this estimate, Sir Sandford Fleming writes: "We have thus presented to us the estimate of the officers of the Post Office Department, amounting in all to £3,264,000. The Canadian Government has a *bonâ fide* tender to carry out in a complete and satisfactory manner precisely the same work for £1,517,000.

"What can be said of such a discrepancy as this? I entertain no doubt as to the great ability, the varied information, and the value of the services of these gentlemen. I can only regret that, in my extremely limited knowledge of them, I should be so unfortunate as to be driven to the conclusion that, however important the offices they fill, their importance does not make the occupants of the office infallible. In short, I am constrained to form the opinion that they have made a grave mistake, and that to this mistake, and to the unfortunate letter of Mr. Lamb in which it is contained, may be traced the seeming antagonism to a Pacific cable, which will be found in the evidence recently submitted."

That the adjective which we have used to describe this estimate is quite warranted, will be at once admitted by anyone with technical knowledge who reads the report in question. The mere suggestion that the core of the cable mentioned should have *equal* weights of copper and gutta-percha (940 lbs. of each) is quite enough, without going further into the matter, to show that the report is utterly valueless. It is obvious that such a report as that above referred to being officially circulated, must have had a most prejudicial effect as far as the Pacific cable project is concerned. We also find that, as far back as September, 1888, in a minute on a letter from the then Secretary of State for the Colonies (Lord Knutsford) the following occurs, above the signature of Sir Charles Todd, who was then, and still continues to be, Postmaster-General of South Australia:—"In face of the known difficulties arising from coral reefs, and the enormous depth of the Pacific along the route proposed, estimated at 12,000 fathoms in some places," &c., &c. After this display of ignorance of a subject, on which his opinion is conveniently accepted by the Government of South Australia, it is not surprising to find in the same minute the following assertion advanced by Sir Charles Todd:—"As the Government are aware, I have given this subject very great and careful consideration, more so, perhaps, than anyone else." In all probability the reference made by this Postmaster to the "enormous depths of the Pacific" can be traced to a blunder in the evidence given by another Post Office official before the Colonial Conference of 1887. We cannot but attribute a handsome share of the misunderstandings and false reports, to the delay in the survey of the Pacific cable route, which was unanimously recommended by the delegates to the Colonial Conference held in London in 1887, and which is not yet completed. The Hydrographer (Admiral Sir W. J. L. Wharton) has in his report dated February 28th, 1887, 10 years ago! (figures corrected to 1892) expressed himself as follows:—"My general conclusion is that if the Government is to aid in a substantial manner any scheme for multiplying the lines of communication to Australia, it should be in the direction of triplicating, by means of sea cables, those portions of the existing route which are now duplicated by foreign landlines."

In view of such an opinion it is not surprising to find that the survey recommended by the Colonial Conference is of slow accomplishment. We may say here that when the Hydrographical Department of the United States undertook the survey for the American cable, soon to be laid from San Francisco to Honolulu, the work (about a third of that required for the Pacific cable scheme) was very fully carried out in three months.

Besides these serious stumbling blocks in the way of the Pacific cable, we must remember that in some of the Conferences held, some of the representatives had no special or technical knowledge of the subject; thus we find that in the Colonial Conference in Ottawa in 1894, the Hon. Thomas Playford, representing South Australia, emphatically asserts (and this after having been corrected) that no soundings from San Francisco to Honolulu had been taken since 1887, which proved that he was quite uninformed of the very complete series of soundings taken by the United States Government in 1892-93 for the San Francisco-Hawaii cable, a matter vitally affecting the subject on which he was supposed to speak with intelligence.

Added to such misconceptions, arising from insufficient or incorrect information, we should not omit to say that the Australian colonies have from time to time been quite satisfied with the reductions of rates which they have received, by using the leverage of proposing to support the Pacific

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* Return to an address of the House of Commons (Canada), dated April 18th, 1893, for a copy of the Report of the Committee appointed by the Imperial Government in 1896 to consider the question of a telegraph cable between Canada and Australasia; also of any reports or correspondence to the Canadian Government from the Canadian representatives on said Committee, or Sir Sandford Fleming in regard to the same subject.

cable, but that after each reduction they have ceased to interest themselves in the project. That the reductions were quite justifiable is proved by the steady increase of the revenue of the company concerned. For information regarding the financial position, revenue, &c., of the Eastern Extension Company, we refer our readers to an analysis made by Sir Sandford Fleming, which we published last week. In conclusion, we would express a hope that the allied companies will not be permitted in any way to close the doors on the progress of telegraph enterprise. Besides the large revenues derived from traffic, these companies, together with others in which they are interested, have already received in subsidies, guarantees, &c., a sum in excess of £3,000,000, and it would be extremely unwise to still further strengthen against competition the position of these "spoon-fed" monopolists.

THERMAL EFFICIENCY OF STEAM ENGINES.

(*Continued from page* 446)

II.

THE first, or preliminary, report of the committee was very brief and consisted of three statements:—

1. That the statement of engine performance in water consumption per I.H.P.-hour is undesirable.
2. That the statement should be in terms of thermal units per I.H.P., and, if possible, per B.H.P. also.
3. That the thermal units for a perfect engine under the same conditions should be stated, so as to give a gauge of the imperfections of the actual engine.

In their final report the committee at once give the thermal efficiency as the quotient of the heat utilised, divided by the heat supplied to the engine. The heat utilised is ascertained by simply converting the work shown by the diagram or brake strap into its heat equivalent.

The heat supplied is that necessary to produce steam at constant pressure from water supplied at the temperature of the engine exhaust, the rule being applicable to both saturated and superheated steam, and to condensing and non-condensing engines.

They consider undesirable the term thermal efficiency, and prefer to say efficiency ratio in comparing an actual with the ideal or perfect engine for the same conditions. The committee had some difficulty in settling on the lower limit of temperature, but finally decided it as being that of the steam in the exhaust pipe close to the engine but outside it, *i.e.*, away from the cylinder. This recommendation is seen to cover engines working against large back pressures or at high altitudes in a low pressure atmosphere. The thermal efficiency of the Rankine cycle is thus formulated:—

$$\frac{(T_a - T_e)\left(1 + \frac{L_a}{T_a}\right) - T_e \text{ hyp. log. } \frac{T_a}{T_e}}{L_a + T_a - T_e} \qquad (1)$$

where T_a is the absolute temperature of saturated steam at the stop valve, and T_e that at the exhaust flange, and L_a is the latent heat of steam at temperature T_a. Calling this thermal efficiency E, the B.T.U. per minute per H.P. for the standard engine of comparison is 42·4 ÷ E.

For the efficiency, E_s, of superheated steam the formula (1) is altered in the numerator by the addition of the quantity 0·48 $(T_{as} - T_a)$ after the second bracket, and by the addition after the final quantity of the expression

$$- \left(T_e \times 0{\cdot}48 \text{ hyp. log. } \frac{T_{as}}{T_e}\right),$$

the denominator being extended by the addition of 0·48 $(T_{as} - T_a)$ where T_{as} is the absolute temperature of the steam at the stop valve. Similarly the B.T.U. for superheated steam is 42·4 ÷ E_s, where E_s is the thermal efficiency as per formula. Curves have been prepared to show the B.T.U. per minute for various conditions. The specific heat of steam is taken as 0·48, but doubts are thrown on its correctness for superheated steam.

The efficiency ratio of an engine is the ratio of the B.T.U. actually consumed by the engine to the B.T.U. required (by the formulæ foregoing) by the standard engine.

Finally, it is recommended that the authors of all papers presented to the Institution bearing on steam engine economy conform to the recommendations of the committee. Appendices are given detailing some of the experiments in the determination of temperatures, and a table of 14 examples of engines under varying conditions reduced to the basis of the report for actual comparison. The celebrated Milwaukee pump which is well known as having given a good record, shows a rendering of only 79 per cent. of its possibilities; this is about the best for saturated steam yet obtained.

GAS PRODUCERS.

A CURIOUS misapprehension occurs in an article on gas producers by Mr. A. Bement in *Modern Machinery*. Mr. Bement describes various gas producers, and refers to the use of producer gas for power purposes as outside serious consideration for internal combustion engines. He then states that where producer gas is made as a bye-product, as in the blast furnace, it may be available for use in gas engines, but, and here comes the most extraordinary statement, "*it must go direct to the gas engine at a high temperature and without much effort at purification as this would result in such reduction of temperature as to prevent combustion.*" Now, what nonsense have we here. The gases from a blast furnace escape at about 500° to 600° F. and occupy therefore about double normal volume.

If used hot a less volume could be admitted to the cylinder and the power of the engine would be reduced. The whole statement is absolutely fallacious, for not only can the gas be purified, and it is also desirable to do so, but it can and should be cooled for use in the Otto cycle engine.

Mr. Bement, however, sees no virtue save in water gas, of which he gives the analysis:—

Hydrogen	51·89
CO	40·08
CO_2	4·80
CH_4	0·10
N	3·13
	100·0

No doubt the above is a sufficiently satisfactory gas for metallurgical purposes requiring a high temperature which cannot be got from poor or producer gas. But to produce this gas steam must be blown through brightly incandescent carbon. In a few minutes the carbon is cooled down below the temperature of water dissociation, and the operation must be stopped and air blown in to get up the heat again during which time producer gas is made and blown usually to waste. To make 1,000 cubic feet of water gas about 60 lbs. of carbon are required, of which about 15 lbs. appears in the gas, and the remaining 45 lbs. goes to waste in the air blow period. In Dillwik's system of water gas production described, the amount of gas per ton of fuel is fully doubled. This appears to be due simply to increased intensity and shorter duration of the air blast period producing a high degree of incandescence, and the following analyses are given of the water gas produced:—

H	52·43	50·09
CO	38·30	39·95
CO_2	4·73	5·38
O	0·74	1·22
N	3·80	3·36
	100·00	100·00

The air blast period gives a very poor gas, of which two analyses show:—

CO_2	17·90	18·80
CO	1·80	1·10
N	78·60	79·50
O	1·70	0·70
	100·00	100·00

Such a strong gas as water gas is not required for power purposes though, as stated above, it is necessary for high temperatures. Certainly, as yet, a high temperature is not wanted in the water cooled cylinder of a gas engine and it is better for power gas to keep up one uniform and steady production, utilising, it may be, as much moisture as the circumstances will admit of being split up in the producer, and thus using some heat otherwise wasted, but not going to the extent of cooling the fuel bed below a point of good efficiency which might endanger the perfect operation. Where Mr. Bement has obtained his ideas of the uselessness of producer and of blast furnace gas in face of their now large use in England, France, Belgium and Germany it is difficult to guess. Only a few days ago we were shown in London two gas engines of 50 H.P. rating working with producer gas of the ordinary "poor" description. The waste in water gas production is not the only drawback to its use. There must be a steam boiler to produce the blowing steam, and at once the old boiler is re-introduced, which it is the mission of gas power to abolish, and we have observed that the boilers of gas-producing plants are rarely presentable.

THE BRADFORD TRAMWAY ACCIDENT.

THE Board of Trade inquiry into the cause of the electric tramway accident in Bradford on Monday 19th inst. was opened yesterday week by Major Cardew, R.E., in the Bradford Town Hall. Mr. F. Stevens, the deputy town clerk, appeared for the Corporation; Mr. H. Waddington, Mr. J. Elliott, and Mr. Tetley represented several of the injured passengers; Mr. T. L. Atkinson appeared for the relatives of the man Drake, who was killed in the accident; Mr. J. A. Bucknill for the Westinghouse Company, which supplied the electrical equipment of the line.

The first witness called was EDWIN EDWARDS, head inspector of the Great Horton line of electric tramways, who produced his daily report, which contained his remarks on the accident

In it he said that after the accident he examined "the car and found that the wheels were badly flatted, as though they had been skidding some distance. The hand brake was in good working order, also the sand-valve gearing. The sand box was empty, but this had evidently been caused by the car going over, as there was a large quantity of sand about the inside of the car. There were also two bags of sand, which had been kept in reserve, under the car seat. He also examined the rails which the car went over, and found them in places completely filled up with sand." Another statement on the same report was as follows:—"Driver Clarkson reports his car running over the end of the line at Morley Street terminus at 2.15 p.m., his explanation being that a street watering cart had made the rails greasy, causing the car wheels to skid. He was delayed about 10 minutes. Driver Pickles (No. 8 car) met with an accident owing to the trolley coming off the wire near the Crown Inn, and getting bent, had to be taken to the depôt."

In answer to questions, Witness said there was a heavy traffic that morning, and he put on two extra cars, and No. 16, the car which was overturned, was one of them. He denied that he had had any complaints as to the running of the cars, save on the first day, when the system was opened to the public. On that day the drivers complained of the brakes. After the first day they were satisfied, but he believed a stiffer brake would be safer, and personally, did not consider the electrical brake sufficient on a greasy rail.

James Speight, fitter at the Horton Bank Top Depôt, said that when the cars left the depôt that morning they were in good working order, there was plenty of sand in the boxes, and there were no flats on the wheels. He admitted on that morning having received a note from the manager, saying, "Look well after the cars at the Horton end, and pay special attention to brakes and sand."

Mr. C. J. Spencer, general manager of the electric trams, stated that he instructed the starting out of extra cars. No. 16 was one of them. There was no driver available, and he sent messengers for one. He ran the car out of the shed himself, and on the way to Bradford met Mongovin, one of the company's drivers. Witness said that on the way down to town he "instructed" the driver as to the use of the brakes, but afterwards he modified the expression, and said what he meant to say was, that he cautioned Mongovin to be careful, as the rails were greasy. He denied having previously received any definite complaints as to the working of the Great Horton line, but added that he was not satisfied with the brake power on the cars when the rails were greasy. He had recommended to the Tramways Committee the necessity for slipper brakes, and they were about to be fixed. He saw danger unless they were attached, and the committee decided on having them a fortnight ago. He had had nine years' experience on electrical tramways, but had not been manager before. He denied that any training was necessary for a conductor, but they always trained their drivers. Mongovin had been a conductor, and had been instructed in driving for a week during his spare time. He was of opinion that the electrical brake should be applied for the purpose of checking speed throughout the whole of a journey from Horton Bank Top, and he would have no fear in driving the cars under present conditions. He admitted that the drivers had no proper meal hours. Asked why the running of the cars was continued after the accident, in face of the greasy rails, he said they soon dried, and after consultation with the chairman, they agreed there was no danger.

Mr. James Parker, of Pickles Lane, Great Horton, volunteered to give evidence. He said he was formerly a member of the Bradford Corporation, and had taken a deep interest in the making of the tramway to that district. He had not desired to give evidence, but had felt that he should, in the public interest, tell what he had observed. He related how that on the 14th inst., he got on to a car at Pickles Lane Bottom, and he had not been in long before the driver set off at full speed.

The Deputy Town Clerk: What do you call full speed?

Witness: Well, I mean it was running away. It was like a runaway horse. Proceeding, witness said the tram stopped at Smith Hill Lane, and on resuming his journey the driver adopted the same speed—like a runaway horse.

The Inspector: Well, that would be about 15 miles an hour?

Witness: Yes, it would be that. When he got to Cross Lane Ends some ladies signalled the conductor, but the driver was quite unable to stop the car. With the remark, "The driver has lost control," witness jumped off the car as it was going at full speed. Before jumping off, witness said to the guard: "This man has had no experience in driving." He replied: "No; he is a guard up Bolton Road. He has had no experience in driving."

Mr. Waddington: Is it your opinion that, as a general rule, from your observations since this line was opened, that the cars have been driven at a greater speed than was conducive to public safety?

Witness: That is it. They have driven over some of the points at such a speed that it is a wonder more accidents have not occurred.

Have you mentioned it to the conductors?—Yes, to the respective conductors. To compare the driving on the two routes, he should certainly prefer to travel on the Bolton Road route.

Mr. Waddington: Are the Horton Road trams driven more recklessly than on Bolton Road?

Witness: Yes, and there ought to be the question raised why it is so.

Witness also complained of certain of the curves on the line, and said on Sunday last he saw a driver jump off his car, look round a curve, and go back again, without ever stopping the car.

The Inspector: Are you prepared to swear that?

Witness: Yes, I am; and I remarked what a calamity there would be if the car began to slip back with no one in charge.

You say you jumped off at full speed the other day? With what result?—Well, I nearly chucked my neck out.

Mr. Parker said he could call witnesses to prove his assertion. He was of opinion that the Corporation could not secure qualified men to act as drivers at 5½ per hour.

There was a discussion at this point as to who should call eye-witnesses of the accident. Mr. Stevens said he had no such witnesses, and Mr. Atkinson said he could not advise a client of his to give evidence, as claims for compensation might follow. He regarded it as the duty of the Corporation to provide further evidence.

The Mayor said the Corporation desired the fullest investigation, and it was arranged to endeavour to get other witnesses after luncheon.

Mr. J. H. Cox, the city surveyor, was called to clear up a point raised as to some work being performed to the permanent way on the Sunday after the accident. He said the work was simply the unscrewing of some tie bars on the up line. The work had nothing to do with the line on which the accident happened.

The Inspector: Is the down line all right in your opinion?

Mr. Cox: Quite right, sir. Previous to the accident no car has run off the line at the curves.

Have you any trouble at all with the curves?—None whatever. He noticed on examining the car after the accident that there was a flat on each wheel extending about 2½ inches. That indicated that the wheels had skidded for a considerable distance. He also stated that there was no opposition on the part of the public to any portion of the route, which was the best they could take.

An adjournment was made for luncheon at this point, and on resuming the Inspector stated that he had visited the scene of the accident, and whilst there had taken the opportunity of getting the evidence of three bystanders. Dr. Sargent stated that the speed of the car down the road was about 12 miles an hour. Mrs. Hustler, of Great Horton Road, told him that she saw the accident. She also stated that this particular car always made a grating noise when running on the up line, and that on two previous occasions it had run off the metals at the corner of Grange Road. The evidence of a man named F. Greenwood, of 236, Horton Road, was to the effect that all the wheels were locked, and that the car was going at a greater speed than six miles an hour. The speed, he said, was more like that of a railway train.

Mr. W. Bennett, of Mount Pleasant, Queensbury, was called, and stated he was an outside passenger on the car when the accident happened. When they were near Canon Mill, some 300 or 400 yards before reaching the scene of the accident, they increased their speed considerably, and a woman called out to the conductor to put on the brake. He did so, using the hand brake, but they continued to gain speed until the car overturned. He did not see the conductor use the electrical brake, and did not notice whether there was sand on the back. There was, however, sand in his pocket after the accident. He thought they travelled about as fast as an ordinary train.

Alderman Cowgill, chairman of the Tramways Committee, in reply to Mr. Atkinson's question as to whether the Committee left the appointment of the drivers with the manager, said the Committee advertised for conductors and drivers, and they got 600 applications. Mr. Spencer was present at all the meetings of the Committee, and he thought the Committee and the manager were capable of selecting the best men. The Committee spent five or six evenings in making the selections. Since then the manager had consulted with him as to the appointments. The appointments, however, had usually been left with the manager. When he thought men were fit he put them on; if he did not think them fit they were not engaged. He admitted, however, that names had been recommended to the manager, though he had not heard of one member of the Committee boasting that he had obtained appointments as drivers for six men. He did not think the drivers could be better selected if they were left entirely to the manager. He asserted that an extra car was put on to allow the men to take their meals at Bank Top, but admitted that the maximum time allowed was a quarter of an hour. Personally, he expressed the opinion that the brake power on the cars was sufficient, and he spoke from experience, having driven them frequently.

At first the Alderman declined to express an opinion as to the cause of the accident, but he was pressed by the Inspector, who asked: I want your opinion as to the efficiency of the brakes. I think you said you have every confidence in the brake power that it is sufficient?

Alderman Cowgill: I will undertake to drive one of the cars at any time.

If that is so, does it not follow that if the man had worked the electrical brake properly the accident would not have happened?—That is the conclusion it comes to in my mind.

Mr. Robert Blackwell, engineering contractor, gave evidence at the request of the Inspector, and stated that in Bristol, where the tramway system was one of the most successful in the country, there was a steeper gradient, narrower streets, and more traffic, and the speed was greater than that run in Bradford. The system was the same at Bristol as at Bradford. He did not think it an advantage for a driver to have an electrical or mechanical knowledge. The less he had, the better for the line. What a man wanted was to know how to work the brake, and a thorough knowledge of the route.

The Inspector: What is your opinion as to the cause of the accident?

Mr. Blackwell: Entirely the human element. My opinion is that the driver lost his head. I do not think he has done as a man should do, after that long experience which makes it impossible for a man to take a false action.

Do you think the driver should have been started after a week's experience?—That must depend upon the man. The drivers were under the supervision of the representative of the Westinghouse Company.

Is it possible to educate a driver in a week?—Yes, to drive slow.

The inquiry was then adjourned until such time as the conductor and the driver, both of whom were injured, are able to give evidence.

REVIEWS.

Introduction to Algebra for the use of Secondary Schools and Technical Colleges. By G. Chrystal, M A., LL.D. London: Adam and Charles Black.

Notwithstanding its title this book seems to be rather an essay on teaching algebra, than an actual manual, and to be addressed to teachers rather than to students. A large amount of space, for an elementary work, is occupied with discussions of the exact meanings of the terms and processes employed, and while the processes only extend to the solution of quadratic equations, the book is prefaced by a list of the names of nearly 250 algebraical terms. Short essays on what are rather philosophical points than points of practice occur frequently, and replace the set theorems usual in books on algebra. The ruling idea of the book seems to be that the student should spend more time than has hitherto been usual on consideration of the conceptions and logical processes employed in algebra, and less in learning artifices for solving problems. The nature of functions is freely illustrated by geometrical applications, and a good deal of space is occupied with analytical geometry. The examples are very numerous.

Engineers who devote their time to practical applications of these things may well hesitate to express an opinion on the educational views of Prof. Chrystal, but the character of his method is so diametrically opposed to the conclusions of our smaller experience that with some diffidence we venture to criticise it.

Comprehension of the nature of the symbols and operations he has learnt to use comes with thought to a reflecting student, and others cannot acquire it; that this comprehension should be acquired is the aim of the mathematical teacher.

In most cases the result will, we think, be reached most quickly by pushing the student through the subject at a fair speed, but it will not be possible for him to take a clear view of his position till he has made some considerable advance. The details of the ascent are best viewed from the top of the hill. Knowledge must precede consideration of the nature of knowledge.

In algebra the theory of equations may well be left till the artifices for solving them have been mastered, and numerous examples solved, when the theory becomes easy and lucid. The theory of functions may be taken after the analytical geometry of conics, and the differential calculus. Quaternions and the use of a potential function then throw a flood of light upon the whole of the earlier subject only comparable to a revelation. This criticism applies, of course, more directly to the accepted mode of teaching geometry than to Prof. Chrystal's work. The course of reasoning of Euclid's first book is only fully appreciable by a logician advanced enough to be dissatisfied with the definitions. Is this repulsive style of argument and definition necessary or desirable to teach a boy to draw a triangle with three given sides, or to prove the forty-seventh proposition? Is not the *pons asinorum* obviously true on statement? It seems clear that a student could learn in a given course of study an immensely larger body of geometrical properties than is proved by Euclid, without undergoing what is to many the intolerable labour of learning him. To many students Prof. Chrystal's unfamiliar technical terms for simple properties of number will prove as repulsive as Euclid, and it appears to us that our own youthful progress in algebra might have been greatly delayed had we been invited to refer continually to its fundamental laws. On the other hand we can remember being greatly encouraged by learning to employ an artifice which was only justified by a later stage of knowledge.

An Introductory Course of Practical Magnetism and Electricity. By J. Reginald Ashworth, B.Sc. (Vict.). London: Whittaker & Co.

This little book describes a series of simple experiments on magnetism and electricity for students under the syllabus of the Science and Art Department. Its aims may best be described by an extract from the author's preface. He says: "In arranging the experiments it has been my aim to use very simple and inexpensive apparatus, so that no school need be deterred on the ground of expense from adding practical to theoretical teaching; to avoid unnecessarily introducing algebraic symbols and formulæ, so that students of slender mathematical knowledge will not find the work beyond their comprehension; and to make the exercises lead progressively from qualitative to quantitative results." Great care and a considerable amount of thought and ingenuity have evidently been given to the work. We should think it is well adapted to its object.

CORRESPONDENCE.

Boosters and Rectifiers.

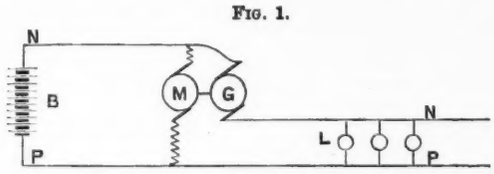
Will you kindly explain how a booster and a storage battery are usually connected together to give the required variation in pressure? For instance, in a recent issue, page 353, first column, last paragraph but three; has the armature of the booster to carry the whole 1,200 H.P. which is the maximum capacity of the cells?

C. B. Nixon.

P.S.—Will you also tell me where I can find the proper definitions both of a "rectifier" and a "booster," perhaps you will kindly give them as they appear to be too modern for the text-books.

[A "booster" is a slang American term for a motor-generator when applied to raise the pressure of an electric circuit. The motor is coupled across the mains as usual, while the generator armature is coupled in series as in figure herewith. N P are the mains of the circuit, B battery, M motor, G generator, L load. The booster does not carry all the horse-power. It carries all the current, adding a few

Fig. 1.



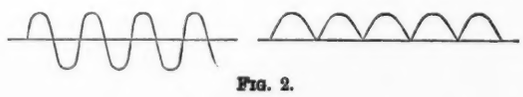


Fig. 2.

volts to make up for the drop due to fall in pressure in the battery; say it adds 5 volts with current of 1,000 amperes, then the motor would carry only a little over 6 H.P., which is a small fraction of, say, 100 kilowatts.

A "rectifier" is a commutator driven by a synchronous alternating motor for the purpose of converting an alternating current into unidirectional pulsating current. The line (fig. 2), being neutral, alternating pulsates as much above as below zero, a unidirectional current pulsates all above zero, never reverses in sign. We don't know where any better definitions than these are to be found.—Eds. Elec. Rev.]

The Production and Applications of Ozone.

M. Andreoli surpasses, even himself, in the number of misstatements contained in his last letter:—

(*a*) He states that I have never seen an ozoniser at work. I have seen several.

(*b*) He states indirectly that I have no practical knowledge of electrolysis. This is absolutely untrue.

(*c*) He states that I hate ozone and disbelieve in its future. The first is absurd; the second is disproved by the latter part of my article.

May I point out to M. Andreoli that he is mistaken in supposing that I am in any sense a competitor with him in his particular sphere. Everyone appreciates that M. Andreoli knows all about ozone that is worth knowing; and some, after

a perusal of all his writings, may be forgiven for believing that he invented it. The mere fact that M. Andreoli is producing a second book upon "Ozone" is sufficient to lift him into the position of an international authority—upon "The Andreoli Ozoniser." As there are at the present time only two industrial applications of ozone operating upon a commercial basis known to me, 400 pages certainly seems rather a liberal allowance of space for treatment of the subject; and without wishing to appear boastful, I may state that I would undertake to compress all the matter of practical value into one-tenth of the space, with copies of M. Andreoli's patents thrown in, to preserve the necessary "local colour" of the publication.

With regard to M. Andreoli's denial of ever having attempted to boom ozone, I am, of course, ready personally to accept it, if the word "boom" be interpreted according to M. Andreoli's definition, and not according to my own, which is evidently slightly different.

With the whole of the correspondence before them, I am afraid, however, that your readers will find some difficulty in deciding—not whether a boom exists—but whether its real object be "Ozone" or "Andreoli."

John B. C. Kershaw.

London, *September 23rd*, 1898.

"Some Motors and a Moral."

In the discussion at the Mechanical Section of the British Association, I congratulated Mr. Gibbings upon the number of motors used on the circuits of the four cities, Manchester, Liverpool, Edinburgh, and Glasgow, which are supplied by continuous currents. I also pointed out that there was one city in which more motors (in total horse-power) were used than in Manchester, Liverpool, Edinburgh, and Glasgow put together; and that this station, of which he conveniently omitted all mention, was supplying single-phase alternate currents.

Why you should represent me as "inveighing in unmeasured terms against continuous current motors, and indulging in a piece of special pleading on behalf of the three-phase system," I do not know. My main endeavour was to point out some facts which Mr. Gibbings had suppressed; and these facts happened to be chiefly not three-phase. In fact, I cited not one single three-phase case in reply to Mr. Gibbings.

Silvanus P. Thompson.

P.S.—Mr. Siemens's crane, which is not used intermittently, is a distinct novelty. A crane that never stops winding up its load would be a joy to contemplate.—S. P. T.

[Prof. Thompson is singularly unfortunate in being occasionally misinterpreted. The foregoing letter, however, makes his position quite clear.—Eds. Elec. Rev.]

The Price of Aluminium.

In Mr. Zingler's letter to you of the 9th inst. he said: "As regards price, everyone knows the reason of the high price of aluminium in England; but the Americans offer to deliver the wire at Liverpool for export at 29 cents per lb."

In this he is mistaken. I am not aware of the reason, and would feel much obliged by his telling us what, in his opinion, is the cause. We heard such a fuss made about getting power for nothing at Foyers, that I am surprised to learn that we cannot even now compete with America. If it is in order to allow of big dividends it does not seem good policy to let the Americans into these markets.

A. L. Steavenson.

[Reply to H. Jones, Worcester.—The Stockport electricity works are to be under the control of the Town Council. Mr. J. N. Shoolbred, of 47, Victoria Street, London, S.W., is the consulting engineer.—Eds. Elec. Rev.]

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending Sept. 27th, 1897.	£	s.	Week Ending Sept. 27th, 1898.	£	s.
Alexandria	70	0	Adelaide	890	0
Amsterdam	50	0	Amsterdam	222	0
Antwerp. Elec. fuses	124	0	Bombay	50	0
Beira	528	0	Calcutta	93	0
„ Teleg. mat. ...	1,060	0	Cape Town	138	0
Bombay	14	0	Colombo...	58	0
Brussels. Teleg. mat....	27	0	Copenhagen	57	0
Buenos Ayres	202	0	Durban	412	0
Calcutta	475	0	Fremantle	53	0
Cape Town	461	0	Hamburg	14	0
Chinde	8	0	Launceston	13	0
Christchurch	9	0	Madras	13	0
Christiania	9	0	Malta	24	0
Durban	30	0	Melbourne	432	0
East London	49	0	Nagasaki	188	0
Fremantle	458	0	Perth	306	0
Gothenburg	1,334	0	Port Elizabeth	44	0
Hong Kong	7	0	Shanghai. Teleg. mat.	22	0
Jamaica	74	0	Singapore. Teleph. mat.	108	0
Lisbon	10	0	Stockholm. Teleg. wire	93	0
Lyttleton	25	0	Sydney. Teleg. cable	210	0
Madras	9	0	Tientsin	108	0
Marionpol	435	0	Wellington	50	0
Melbourne	75	0			
„ Teleg. mat.	1,402	0			
Port Elizabeth	64	0			
Rosario	290	0			
„ Teleg. cable ...	568	0			
St. Petersburg. {Teleg. wire}	69	0			
Santos. Teleg. mat. ...	18	0			
Shanghai	199	0			
Singapore. Teleph. mat.	74	0			
Stockholm. Teleg. wire	188	0			
Trinidad...	25	0			
Vigo. Teleg. cable ...	7,000	0			
Wellington	396	0			
„ Teleg. mat.	90	0			
Yokohama	384	0			
Total	£16,110	0	Total	£5,618	0

Auction Sale.—Messrs. Percy Huddleston & Co. are to sell by auction on October 13th at Braunstone Gate, Leicester, by order of Messrs. Gent & Co., two 9-H.P. Robey gas engines, and five dynamos by Mather & Platt, Scott & Mountain, and Royce, also various measuring instruments, switches, telephones, telegraphs, &c., &c. See our "Official Notices" this week for further particulars. We understand that this sale is being made by Messrs. Gent on account of their removal to larger works.

Bankruptcy Proceedings.—On October 3rd, at 12 noon, the first meeting of creditors in *re* H. D. McIntyre, of Putney (Glanamman Colliery Company) colliery proprietor and electrical engineer, will be held at the Official Receiver's offices, 31, Alexandra Road, Swansea; the public examination will take place on October 12th at 11 a.m. at the Guildhall, Carmarthen.

Dissolutions of Partnership.—Messrs. J. Lowsby and S. H. Croker (Croker & Co., 12, Smithdown Road, Liverpool), cycle agents and electrical engineers, have dissolved partnership. Debts will be attended to by Mr. S. H. Croker.

Messrs. H. J. Robinson and E. V. Smith (Robinson & Smith, Heathfield Road, Handsworth), cycle manufacturers and electricians, have dissolved partnership by mutual consent.

Liquidation Notice.—The shareholders of the Globe Electrical Advertising Syndicate, Limited, resolved at meetings held at Nottingham recently to wind up voluntarily. Mr. T. C. Leman, 1, St. Peter's Church Walk, Nottingham, was appointed liquidator.

British Insulated Wire Company v. Dublin United Tramways Company and Another.—In Dublin, on September 22nd, before Mr. Justice Kenny, the case of the British Insulated Wire Company, Limited, *v.* the Dublin United Tramway Company and the National Conduit Company, of New York, was heard. The plaintiffs sought for an interlocutory injunction to restrain the defendants from infringing certain patents owned by plaintiffs for the manufacture of cables used in electric traction. The patents relied on were for an invention relating to the insulation of the copper wires of electric mains from the outer lead covering of the cables by spiral folds of oiled paper. It was shown by the affidavits that the Dublin Tramway Company had purchased large quantities of cables from the New York Company and were laying them down in the city. The motion was adjourned to the next sitting to give the Tramway Company time to obtain materials for the defence from New York.

Changes of Address.—The offices of Mr. Sherard Cowper-Coles have been removed from 39, Victoria Street to 26 and 27, Grosvenor Mansions, Victoria Street, and all communications should be sent to that address.

The registered offices of the London Electric Omnibus Company, Limited, are now at 11, Queen Victoria Street, E.C.

Coolgardie Exhibition, 1899.—We have received a number of documents relating to the Western Australian International Mining and Industrial Exhibition, which is to be held at Coolgardie next year. The exhibition is under the direct patronage of the Western Australian Government, and it will open on March 21st, 1899, remaining open for about three months. Application forms for space and any other particulars which may be desired can be obtained upon inquiry at the London office of the Exhibition, 18, Queen Victoria Street, E.C., or at the Agent-General's office, Victoria Street, S.W.

Cox Thermo-Electric Company's Liquidation.—Under a winding-up order recently made against the Cox Thermo-Electric Company, Limited, the statutory meetings of the creditors and shareholders were held last Thursday week at the Board of Trade offices, Carey Street, Lincoln's Inn Fields. Mr. Cully, assistant receiver, reported that none of the directors had yet attended, but information had been obtained from Mr. Webster, the company's solicitor, and who formerly acted as the secretary. The company had had a very short existence, it having been incorporated in February, 1896, with a nominal capital of £100,000, divided into 10,000 shares of £10 each. It was formed to acquire certain patents from Mr. Cox at a price of £104,000, payable as to £100,000 in shares and £4,000 in cash. The directors of the company were Mr. Roger Wallace, Q.C., Mr. Julius Möller, Mr. J. Brown Martin, and Mr. H. B. Cox. Their qualification was the holding of £500 shares, and no remuneration was either voted or paid to them. No prospectus was issued, but the shares were duly allotted, and consequently the whole of the share capital of the company went to the vendor in the purchase of the patents. A further £4,000 in cash had to be provided in order to carry out the agreement, and the directors subscribed £10,000 for debentures, covering the whole of the company's property, and carrying 6 per cent. interest. By those means the company acquired certain freehold property at St. Alban's, wherein to carry on the work of the company, but in February, 1897, the premises were destroyed by fire. It appeared that they were only insured for £1,000, and in order to rebuild them the directors raised money from the bank on depositing there the deeds and giving their personal guarantee for the repayment. A sum of £3,000 was raised in that way, the premises were rebuilt, and a certain amount of work was carried on, but it seemed to have been directed to the development of the patents, and they had turned out anything but a commercial success. As a result, in March, 1898, a debenture action was commenced, and a receiver was appointed, who was now in possession of the property. A draft statement of affairs had been lodged showing unsecured debts £5,206 17s. 10d., and assets likely to yield £257 9s. Then there was the £3,000 due to the bank who had a charge over the freehold premises at St. Albans, and, lastly, there were the debenture bonds of £10,000. The points which naturally struck one with regard to the company were that under the purchase contract the whole of the share capital was allotted to the vendors. He thought that was illegal, because the Companies' Acts provided that a company must consist of not less than seven members, and it followed that if the whole of the share capital was allotted to one man that requirement could not be complied with. It was true that there were seven signatories to the memorandum and articles of association, but a signatory had to take at least one share from the company, and in this case it was obvious that they could only take them from the vendor. It further appeared that the company started without any working capital and was obliged to give a charge over the whole of its assets to provide the premises and a portion of the purchase consideration. Consequently, unless the company proved successful—and the patents at that time were practically unproved—it was difficult to see from what source the creditors were to be paid. The directors certainly subscribed £10,000 for the building of the premises, but they were destroyed by fire, and a charge had to be given to the bank for the rebuilding. The Official Receiver found that a great many of the present debts had been contracted since the fire. That was a matter requiring the careful consideration of the liquidator and strict investigation by the Official Receiver. Another point was that under the articles of association the directors' qualification was the holding of £500 shares. It was obvious that they had to qualify through the vendor, and, as a matter of fact, shares were issued to the directors as nominees of the vendor. It was stated that they were allotted in consideration of the directors subscribing for the debentures, but it appeared that they were not allotted until long after the issue of the debentures. The deficiency account showed that the whole of the money had gone either in loss by the fire or in attempting to develop the patents. Further information would be obtained from the directors at the earliest date. Mr. Gerald Paxon, who attended on behalf of the petitioning creditors, asked whether it was proposed to apply for a sitting for the public examination of the directors. The chairman said it was too early a stage of the proceedings to express any opinion on that point. Mr. Webster was asked whether an offer of 13s. 4d. in the pound made to the creditors a few months ago would be repeated. He stated in reply that his clients were out of town, but they were still of the same mind that they did not want the creditors to suffer, and if the meetings were to be adjourned, an offer would in all probability be submitted. After some further discussion the meeting was adjourned for a fortnight to enable the offer to be put forward.

Electric Light Fittings.—Messrs. Drake & Gorham have just brought out a new fittings catalogue for the purpose of the electrical trade generally. There is an excellent collection of artistic designs of brackets, standard lamps, candlesticks, pendants, dining table lighting fittings, &c. Some of the specimens shown are exceedingly delicate and pleasing to the eye. There is also a display of artistic talent in the manner of arrangement of the fittings for the purpose of illustration in this catalogue. Every alternate page consists of one large block showing, by the aid of the camera, a large number of the fittings as they appear on show at Messrs. Drake and Gorham's establishment. Although some of the pages show as many as 40 or more fittings, the detail of each is very clear. Facing the illustrations are particulars and prices.

Electrical News from the River Plate.—The following items of electrical interest are taken from the *Review of the River Plate*:—

Mr. Arthur H. Preece, consulting electrical engineer to the Primitiva Gas Company, has arrived out from London, and will remain here for a few weeks.

The amended rules of the Institution of Engineers of the River Plate have now been printed, and a further meeting for the definite formation of the Institution was held early in September.

The new power and light station of the General Electric Company of the city of Buenos Ayres in the Paseo de Julio is making rapid progress, and when finished will be the finest of its class in the country. The station of the German Electric Light and Power Company is also progressing rapidly, and before many months are over both stations will be at work.

The River Plate Electric Light and Traction Company will soon give a 24-hour service.

The contract has been signed by the Buenos Ayres Municipality granting a concession to Mr. Carlos Bright for an electric tramline to the new Mataderos, passing through Flores, with a branch to Belgrano, through Calle Córdoba and Rivera. This line is to be constructed as rapidly as possible, and the generating machinery and some 45 kilometres of line are already on their way out from the States. When this line is constructed, the inhabitants of Belgrano and Flores will not feel as if they were separated by some 30 kilometres, instead of the three or four which is actually the case. To-day it takes over two hours to reach one place from the other; the trip will soon be accomplished in about 20 minutes more or less.

Mr. Sloan, of the firm of Siemens Bros., of London, has arrived out per R.M.S. *Thames*. His visit is in connection with the contract for the public lighting of the city of Buenos Ayres.

"Electrically Propelled Carriages."—With this title Messrs. W. C. Bersey & Co., of 39, Victoria Street, S.W., have just issued a catalogue got up in very elaborate style, in which Mr. Bersey dilates upon such matters as electrical traction and electric motors. There is also a lengthy description, accompanied with illustrations, of the carriages of the London Electrical Cab Company, Limited, the method of working, and arrangements for supplying the electricity. For the most part the book consists of reprints of articles and paragraphs which have appeared in the technical and newspaper press regarding the electric cab system. The illustrations are excellent and are very well printed, special glazed paper aiding considerably in this direction.

Evening Classes.—The prospectuses of the classes arranged for the South-Western Polytechnic, Manresa Road, Chelsea, S.W., have been issued. The electrical engineering evening classes are under the control of Mr. Herbert Tomlinson, B.A., F.R.S., with Mr. Alfred Schwartz, A.K.C., A.M.I.C.E., &c., as assistant professor, and Mr. R. Beattie, B.Sc.; Messrs. W. R. Kelsey, B.Sc., and Ulrich Oschwald, B.A., are demonstrators; Messrs. J. Hall and G. Earthy, instructors, and Mr. H. W. Baker, steward. The instruction is in elementary and advanced magnetism and electricity, elementary electrical engineering, advanced ditto, alternating and polyphase currents, telegraphy and telephony, electric wiring and fitting. The prospectus gives some excellent photographs of the various laboratories, workshops, &c. Copies obtained on application to the secretary. A similar compilation is devoted to the day classes.

Falcon Works Cycle Club.—The Falcon Works Cycle Club, Loughborough, mustered a record attendance on Saturday last when, at the invitation of Mr. Percy Sellon, a run was made to St. Bernard's Monastery, Charnwood Forest.

Fires.—We are informed that a fire occurred early on Sunday morning at the electric lighting station, Northumberland Wharf, Blackwall, a wood and corrugated iron building being completely burnt out.

A Newcastle paper says that a fire, supposed to be caused by an electric light wire coming in contact with some drugs, broke out at Messrs. Daniel Lee & Co.'s Print Works, at Castleton, near Heywood, and raged for several hours. The damage is estimated at over £10,000.

Holmes v. National Telephone Company.—Before Mr. Justice Channell, sitting as Vacation Judge in the Chancery Division on Wednesday, counsel applied *ex parte* in the case of Holmes *v.* National Telephone Company for leave to serve notice of motion on the defendants for next Wednesday, and for an interim injunction meantime to restrain defendants from setting up poles or making excavations in a roadway, the freehold of which was vested in the plaintiff. Mr. Holmes was the owner of two estates named Brookham and Brookfield, which his Lordship would see marked on the plan supplied. In one place the whole of the road belonged to him, because the estates were on both sides, and in other parts extended along a considerable distance. The National Telephone Company were now proposing to put up telephone poles without his leave.—Mr. Justice Channell: They have not any statutory rights.—Counsel said the company was an ordinary limited company, and had no special rights whatever.—Mr. Justice Channell: Very well; you may take an interim injunction.

Insulating Varnish.—We have received from the Sterling Varnish Company, Birmingham, particulars of an insulating varnish they have brought out in their American factories specially for electrical work, and which they are now introducing into this country. They claim that it can be used to advantage for armature and field coils, for insulating armature core plates, for

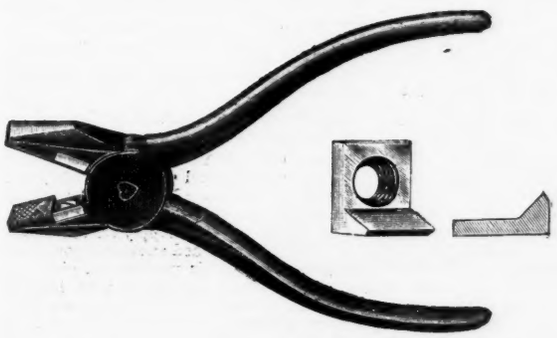
transformer coils, and for various minor purposes. As an insulator they claim for it a very high and uniform resistance. Samples of copper and canvas coated with the varnish have been submitted, and the flexibility of the varnish—one of the points claimed—is undoubted. While it is intended as a baking varnish, it will suffice for many purposes simply to air dry.

Outing.—Messrs. Rawlings Bros., of Kensington, last Saturday gave an outing to those of their employés who were engaged in fitting up "Woodnorton," the Worcestershire seat of H.R.H. the Duke of Orleans. There were between 20 and 30 in the party. Sixty employés had recently returned to London from Worcester or the party would have been considerably enlarged. After arriving at Worcester the party went by steam launch up river to Holt Fleet. A cricket match was followed by dinner at the Holt Fleet Hotel. There were a number of toasts. The return trip to Worcester, tea, and a musical evening, brought the proceedings to a close.

Wood Casing.— Messrs. Kenyon & Moulding, timber merchants, &c., of Montague Street, Blackburn, send us a new list dated September 1st, of electric light wire casings and covers.

Wynn, Timmins and Co.'s Specialties.—Messrs. Wynn, Timmins & Co., Limited, Birmingham, send us particulars of a new calliper gauge for measuring in B.W.G. the thickness of tube, sheet, or wire from 5 to 25 B.W.G. It is of convenient size for the pocket

(the illustration is half size). For measuring sheet or tube it is extremely convenient as the measurement is taken over the burr made in cutting or stamping, while for tubes it can be used where the diameter would not admit the ordinary wire gauge. The gauge is accurate to a minute fraction. We have also seen their wrought-steel cutting pliers for linesmen's work, with interchangeable silver-steel



cutters. These are made only in 8-inch size for heavy work and with them a No. 8 B.W.G. wire can be cut with ease; in fact, they will cut No. 8 silver-steel without injuring the cutter. When worn out the cutter can be replaced in a few minutes as they are made identical in size.

ELECTRIC LIGHTING NOTES.

Alderley Edge.—Last week the District Council confirmed the action of the Electric Lighting Committee respecting the notice which had recently been served upon the Council by the Alderley Edge and Wilmslow Electric Supply, Limited. The notice had reference to certain works which the company proposed to carry out in various parts of the Alderley Edge district. The Committee of the Council recommended the Council to call upon the company to send in amended plans which would show the area of supply. It was decided to at once serve a notice of various amendments upon the company.

Barmouth.—Recently a motion was passed by the Urban District Council in favour of lighting the town by electricity. It has now, however, been decided that the matter shall be left in abeyance for a short while. The provisional order will not, it is understood, be applied for until February, and in the meantime it is believed things will work out all right.

Bath.—At last week's meeting of the Electric Lighting Committee, Mr. Metzger, the city electrical engineer, presented the Works Committee's report, which stated that they had resolved that Mr. Hammond should give the Electrical Construction Company formal notice by the 19th that full penalties for the non-completion of the contract to time would be enforced by the Bath Corporation unless any delay took place in the meantime by unavoidable accident in the completion of the first engine and alternator. Mr. Hammond stated he had intimated to the Electrical Construction Company that they were under penalty and had been since July 16th. He, however, had not written a legal notice, acting on his own discretion as the sub-Committee authorised him. He was perfectly confident that the delay which had occurred was not in any way prejudical. With regard to the arc lamps, the Works Committee stated that Mr. Hammond had informed them that no more money would be granted the Electric Lighting Company in respect of the arc lamps until they worked as noiselessly as the selected sample lamps. Mr. Hammond said they had only paid 80 per cent. of the money to the company, and there was a stipulation in the contract that if the lamps were not in sound repair and working order he could withhold his certificate. He had made it perfectly clear to the company that he did not consider they had fulfilled their contract, and for the last eight days one of their men had been overhauling the objectionable lamps. The contractors had at first said they considered they had washed their hands of the lamps, but they now saw they were under an obligation to make them to Mr. Hammond's satisfaction, and that the lamps would not meet with his approval until they were to the Committee's satisfaction. It was mentioned that many of the lamps at times were noisy and then were the reverse. The report was adopted.

Barrow.—The chairman of the Electric Lighting Committee (Mr. J. P. Smith) writes to a Barrow paper on the cost of the electric light in private houses for the purpose of convincing the public. He produces figures showing the comparative costs of gas and electric lighting in his own residence, which was wired in 1893:—

Cost of Gas Lighting at 3s. per 1,000 Cubic Feet.

	£	s.	d.
1890	5	7	1
1891	5	16	8
1892	5	11	4

Average—£5 11s. 8d.

Cost of Electric Lighting at 6d. per Unit.

	£	s.	d.
1894—224 units at 6d.	5	12	0
1895—186 " "	4	13	0
1896—230 " "	5	15	3
1897—218 " "	5	9	0

Average—£5 7s. 3d.

Buluwayo.—Mr. Kiddy has been appointed municipal electric light inspector at Buluwayo at £150 per annum. This is in addition to his present appointment as Government electrician.

Camberwell.—At a meeting of the Vestry last week, the General Purposes Committee announced the receipt of notice from the London Electric Supply Corporation of intention to lay distributing mains in George Street and Waterloo Street.

Cheltenham.—At a meeting of the Lighting Committee, which was held on September 22nd, a letter from an assistant secretary of the Board of the Board of Trade was read, stating that an application by the Corporation for a provisional order, so as to include the whole of the existing municipal borough, would receive the consideration of the Department; but for an order extending the area of supply beyond the limits of the borough, notice of application must be given to each of the local authorities whose districts it is proposed to include in the extended area on or before July 1st in the year in which such application is made. It was resolved that the Deputy-Mayor be requested to call a special meeting of the Council on October 24th to consider the question of applying to the Board of Trade for an amendment of the Cheltenham Electric Lighting Order, 1890, by extending the area of supply described in the first schedule to the said order to the whole of the said borough, or such part or parts thereof as may be determined on.

China.—The *Times* says that "General" Tcheng Ki-tong, who was formerly attaché to the Chinese Legation in Paris, is now in charge of a new Bund that has been formed along the river front opposite the native city of Shanghai. What his general functions in that capacity may be is not clearly apparent, but it is worth noting that he has got the road lighted by electricity, and that it is expected that the electric light will be introduced into the city itself during the current year, together with a water supply, the works for which have also been begun. Those who know Chinese cities will know how much this means.

Country House Lighting.—Messrs. Rawlings Bros., of Kensington, have recently been engaged putting electric lighting plants into two country mansions for the Duke of Orleans. At "Woodnorton," the Duke's seat at Evesham, Worcester, there are about 800 lamps, and a few small motors. The plant comprises two 12½-B.H.P. Fielding & Platt oil engines, two 10-H.P. compound "Taunton" dynamos, two sets of E.P.S. accumulators, L 27. The switchboard consists of two C and D boards, with special interconnecting switches to allow all or any of the plant to run in parallel. The fittings were specially designed and manufactured at Messrs. Rawlings's works. This firm also carried out the whole of the water and heating arrangements. At York House, the Duke's house at Twickenham, the installation comprises two 16½-B.H.P. Paris-Singer vertical engines, directly coupled to two compound "Taunton" dynamos of proportionate output. There is one set of D.P. accumulators, and one set of Chloride cells. There are two C and D switchboards, with special inter-connecting switches, to allow all or any of

the plant to run in parallel. The plant will supply about 900 and a few small motors. The fittings are mostly of Louis XVI. style, from Paris. Here also Messrs. Rawlings carried out the whole of the drainage, water, and heating arrangements.

Ealing.—At a recent meeting of the Council, Mr. Norris moved: "That the Electric Lighting Committee be instructed to present a report of their work from its commencement until the present time, such report to state what developments they propose to make (if any) in the near future," but the motion was lost.

Enfield.—At the District Council on Thursday last week, it was reported that at a conference of the local authorities of Middlesex at the Guildhall, Westminster, convened by the Finchley District Council, in regard to public lighting by electricity, the following resolution was passed:—"That the various local authorities be asked to transmit to the Finchley Council the decision arrived at by them respectively on the question of combined areas for the supply of electric energy, and that it be left to the Finchley Council to call a meeting of the representatives of those authorities favourable to combination, with a view to further action being resolved on if necessary." The Council decided to reply that they were prepared to favourably consider combination in the matter. A representative of the Electrical Power Distribution Company, Limited, is to meet a committee of the Council and explain its scheme.

Gibraltar.—The electric light is to be installed in Government quarters at Gibraltar in November, whilst the public thoroughfares will be illuminated in the same manner a few weeks later.

Gloucester.—At a meeting of the City Council held on Tuesday, the sub-committee of the Electricity Supply Committee recommended, and it was agreed, subject to the approval of the Local Government Board, to purchase Mr. Browning's property at £4,000, and to make an amended application to the Local Government Board to sanction the purchase of the Bearland Estate and Mr. Browning's property for the purposes of the proposed electricity works.

Greenock.—There were 29 applications for the position of resident electrical engineer. Three of these candidates are to meet the Finance Committee.

Hackney.—The Vestry is accused by the Moderate party and some other members of rushing through the resolution passed on 14th inst. appointing Mr. Robt. Hammond to report upon electric lighting and dust destructors for 100 guineas. A special meeting was held on Friday last to receive a protest from these objectors, who said they had had no opportunity of ascertaining the "fitness" of Mr. Hammond for the post. The whole affair, however, seems to be but a specimen of what may be expected in connection with the Hackney scheme. The Moderate party is a long way in the minority, and it seems bent upon preventing the majority from making any headway. We wonder which member of the opposition is in a position to judge of the fitness or otherwise of Mr. Hammond. But there, this was only a peg upon which to hang a 3½ hours' acrimonious debate. It transpired that the names of some members had been set to the requisition calling the meeting without their consent, therefore the meeting closed without doing anything but talk, the resolutions rescinding the decision not being put to the meeting.

At Wednesday's Vestry meeting, Mr. Hammond's appointment was passed.

Hampstead.—The vestry clerk has submitted the following comparative summary of the accounts of electric light consumers for the Midsummer quarters in 1897 and 1898 respectively:—Midsummer, 1897.—Electric current, £2,010 7s. 1d.; meter rent, £108 13s. 2d.; other charges, 10s.; total, £2,119 10s. 3d. Midsummer, 1898.—Electric current, £3,082 6s. 1d.; meter rent, £174 13s. 2d.; other charges, £3 5s. 6d.; total, £3,260 4s. 9d. This showed an increase for the quarter of £1,140 14s. 6d.

At a recent Vestry meeting Mr. Farmer asked when the electric light would be laid on in the High Road, Kilburn. Mr. Hall, chairman of the Lighting Committee, said this Vestry was still waiting for the decision of the Willesden District Council.

Hythe.—The Town Council last week considered the advisability of applying for a provisional electric lighting order. The question arose in consequence of an application from the Folkestone Electrical Supply Company. It was decided to take preliminary steps, but before expense is incurred, the matter will be confirmed by the Council.

Inverness.—The Electric Lighting Committee have had before them the question of introducing the electric light into the town. It was suggested by the engineer employed to draw up a report, that the water from the Caledonian Canal should be used as motive power, it being said that a fall of 30 feet could be obtained near Inverness. It is calculated that an annual payment of £600 would secure water to produce 500 H.P., sufficient to maintain 5,000 lamps of 16 C.P. each. Further consideration of the scheme has been deferred.

Lancaster.—The installation of the electric light in St. Mary's parish church is almost completed. The work has been supervised by Mr. Parkinson, the electrician, at White Cross Mills. There are two 8-light chandeliers in the sanctuary, seven "6-lights" in each of the aisles, and seven smaller lights in the gallery. Three massive candelabras will illuminate the nave.

Leicester.—Last Tuesday the Council received Alderman Lennard's financial statement of the electricity department for the half-year. The total receipts were £3,559 against £2,402 last year, and the expenditure was £1,804 against £1,402. The net profit is £1,755 against £999, or 6·61 per cent. against 5 per cent.

Lewisham.—The Lewisham Board of Works, which has control of a large area extending from Blackheath to near the Crystal Palace, intend applying to the Board of Trade for a provisional order for supplying the electric light to the district.

Llandudno.—Mr. J. G. Griffin has been appointed assistant engineer at the Council's electricity works at £100 per annum. Mr. Preece has reported that everything is going on satisfactorily at the works, and current would be available within four weeks. It has been decided that premises consuming more than 15,000 units in one year be supplied at an uniform charge of 4½d. per unit, and that, provided the Craigside Hydro accept the above terms, and also undertake to take current for a period of not less than 10 years, the Council be recommended to lay down a new main at a cost of £800.

Maidstone.—Before advertising for electric lighting and dust destructor schemes, for which it is proposed to offer a premium of £100 for the best, the matter is to go before the Electric Lighting and Drainage Committees, so that they may decide upon a site for the works, so that competitors might have something to go upon.

Newington.—On 23rd inst. the foundation stone of the Newington electric light station in Pemrose Street, Walworth, was laid by Mr. W. Edwards.

Norwood.—The Local Government Board has sanctioned the Croydon County Council's application for a loan of £23,262 for the purposes of electric lighting extensions to Norwood.

Petersfield.—After a three hours' discussion on 22nd inst. the Urban District Council decided, by five votes to three, to apply for a provisional order for electric lighting. An interesting feature of the discussion is afforded by the speeches delivered by directors of the gas company who hold seats on the Council. A member says he intends testing the legality of their votes. The gas company seems to be giving anything but satisfaction, therefore this order will be obtained, not necessarily for the Council to carry out the powers itself, but to give it the whip hand over the gas interests.

Rhyl.—The Urban District Council have resolved that the members shall, in a body, visit some of the Lancashire seaside towns, including Southport, Blackpool, Morcambe and Fleetwood, to inspect the electrical works there.

Sheffield.—The Sheffield Electric Light and Power Company is notifying the public that it is in a position to supply motive power at from 2d. to 1d. per unit, according to quantity.

Spain.—Tenders have just been invited for the concession for the electric lighting of the town of Pravia (Oviedo province) during a period of 30 years.

Stretford.—The sympathy of our readers is desired on behalf of the Urban District Council of Stretford. These good people do not wish to be fed electrically with the Manchester spoon, so they decided some years ago to have an electrical scheme of their own. In October, 1896, they obtained a report from Mr. F. F. Bennett, of Manchester, who recommended the use of two generating stations placed about two miles apart, with a 460 volt supply on the three-wire system. In February, 1898, they obtained another report from Prof. J. A. Dawson, of London, who, like his predecessor, gives the subject his most careful consideration, and agrees with him in nothing except a recommendation to the Council to put down their own works; so now there is every prospect that the history of York will be repeated. Each of the consulting engineers holds views diametrically opposite to those of the other, so the Stretford Council must either educate itself sufficiently to make an intelligent choice between them, or it must toss up; this latter expedient usually produces quite as good results as the former, especially when both schemes are good. Of course, in cases where both schemes are bad, the result must necessarily be disastrous. In our opinion the Stretford Council should adjourn the subject until September, 1901, and make good use of the time by attending two lectures a week on electrical engineering. They will then be able to choose for themselves, and will beat York by some years. To the ordinary man of business this advice may seem ridiculous; but then he does not understand how councils conduct their affairs. He can make up his mind in five minutes, but if he had 40 minds to make up it would probably take him five years—particularly if at least 39 out of the 40 minds understood any other business better than the subject in hand. It is a marvel to us how lightly corporations and committees plunge into the problems of electrical distribution of power. They learn the difference between volts and amperes, and then march along merrily. We know the difference between ham and bacon, but we do not feel competent to manage Lipton's.

Turkey.—The Constantinople correspondent of the *Standard* says that Sir E. Ashmead Bartlett, M.P., has obtained a concession from the Porte for the electric lighting of Smyrna and Salonica, together with the electric traction for tramways. He was also promised the preference, if ever a similar concession were granted, for the same purposes in Constantinople. The principal value of the concession for Smyrna and Salonica consists in the priority of right which it establishes in Constantinople, where alone a large profit from the use of electricity could be expected.

Walthamstow.—A Local Government Board inquiry was held on Wednesday respecting an application of the District Council to borrow £41,690 for the purposes of electric lighting.

(*Continued on page* 493.)

THE LIGHTING OF A THEATRE.

With the extension of public lighting mains into almost every part of London, it is not surprising to find that private plant for theatres and similar buildings is fast disappearing. There is much to be said against a theatre operating its own lighting plant, but even in these days of public supply there is still something to be urged in its favour. To obtain a supply from the public mains means that it is not necessary to keep so large and so skilled a staff as would be necessary if a private plant were employed; no trouble from vibration is likely to occur in the theatre or be transmitted to adjacent buildings, and there is under most circumstances probably less liability of a theatre being plunged into darkness. On the other hand, a private plant, if skilfully operated, will supply current at infinitely lower rates than is offered by public companies, and lends itself better to those special stage effects that can be only created by the throwing on and off of large currents of electricity. This is especially valuable at times of rehearsal, when occasionally a heavy demand for current may arise. Moreover, it gives two strings to one's bow, for even with a private plant the usual practice is to be connected up to the street mains, and thus a prolonged and total extinction of light is less likely to occur than if a theatre relied absolutely on the public mains.

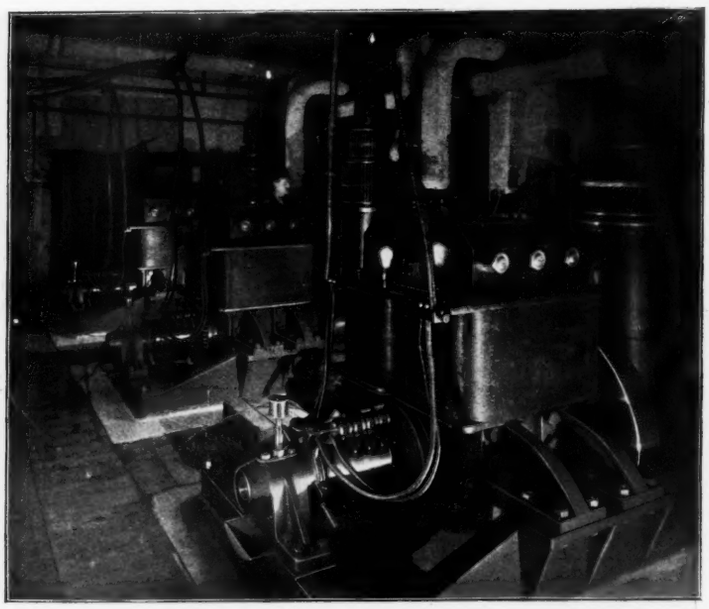
The Foyer at the Palace Theatre.

As we have suggested, most theatres nowadays rely on the public service for lighting, notwithstanding that some of them have to this day plant lying idle in their basements. Whatever reasons such places may have had for abandoning their private supply, it is plain that they have not yet operated at the Palace Theatre of Varieties, where a most complete system of private lighting is still in vogue. Structurally and decoratively, we suppose this theatre is still the finest in London, and everything harmonises; the entertainment, the music, under Mr. Alfred Plumpton, and the lighting are among the remarkable features of what has been termed the most luxurious and the most comfortable building in Europe. So great is the confidence of the management in electricity, that gas has been completely banished, and there is not a single gas jet in the house; even the spirit lamps formerly employed at the bars for heating purposes have been replaced by electrical heaters.

We have recently made a detailed examination of the whole of the lighting plant that is employed here, and our experience is worth repeating. To start in logical order, it is necessary to make a descent—somewhat perilous to anybody but a sailor—to the engine and boiler rooms, which are some 24 feet below the level of the pavement. Here are installed, in a space that suggests some ingenuity in arrangement, three Marshall semi-portable locomotive boilers, which, at a steam pressure of 150 lbs., develop 80 horse-power. How to clean these boilers had been apparently a problem, for the back comes within 3 feet of the wall. Mr. W. Slade Olver, the chief engineer, surmounted the trouble in a somewhat ingenious manner, by having square holes cut in the wall immediately in the rear of the boilers, which gave access to a cellar, and the space thus provided enabled the stokers to operate their cleaning rods. There are not all the refinements in connection with the steam raising plant that one is accustomed to in central stations, and they would be obviously out of place; for instance, hand firing is considered good enough. There are, however, two Berryman feed-water heaters and vertical steam pumps made by Deanes. Owing to the height of the building, the chimney shaft does not project more than 8 ft. above the roof, and, as a matter of fact, can be scarcely noticed at all. It is a point of some interest to observe that the water supply is obtained from sunk wells. The engine room is divided from the boilers by a party wall, and here are erected three Willans-Siemens sets. We have endeavoured to give an idea of the engine room by means of photography, but, owing to the almost entire absence of daylight, artificial illumination had to be resorted to, hence the machines lack the distinctness that one usually obtains in central stations. The engines are of the single-acting central valve H H type, and the dynamos are of Siemens shunt-wound type, each giving 650 amperes at 110 volts. Beyond the paralleling switchboard, which is provided with the ordinary station voltmeter and ammeter, there is nothing more of importance in this room. The whole of the plant is, however, placed on a huge block of concrete, which is completely isolated from the side walls. Although such an arrangement of foundations has not in some places proved a bar to vibration, it is significant that at the Palace Theatre no tremor whatever is observed in the interior of the building. On the roof faint pulsations can be observed occasionally, but then there is no one to complain of that. In any event, it would be a matter of extreme difficulty to communicate vibrations to surrounding property, for the theatre itself is completely isolated from other buildings. In addition to the dynamos there is a battery of accumulators, con-

sisting of 56 Epstein cells. The two halves of these are charged in parallel, four cells being utilised for hospital purposes. A battery regulating board is provided, furnished with the necessary devices.

The mains from the engine room switchboard are carried to three main boards, two of which control the lighting in the auditorium, passages, stairs, vestibule, &c., and the third board controls the whole of the stage lighting. There are, therefore, three main circuits, called, respectively, A, B, and C, the former one representing the stage circuits, the other two the front of the house. In accordance with the County Council regulation, the entrance and exit lights are arranged alternately on B and C circuits, so that in case of one circuit failing every other light would be still on.



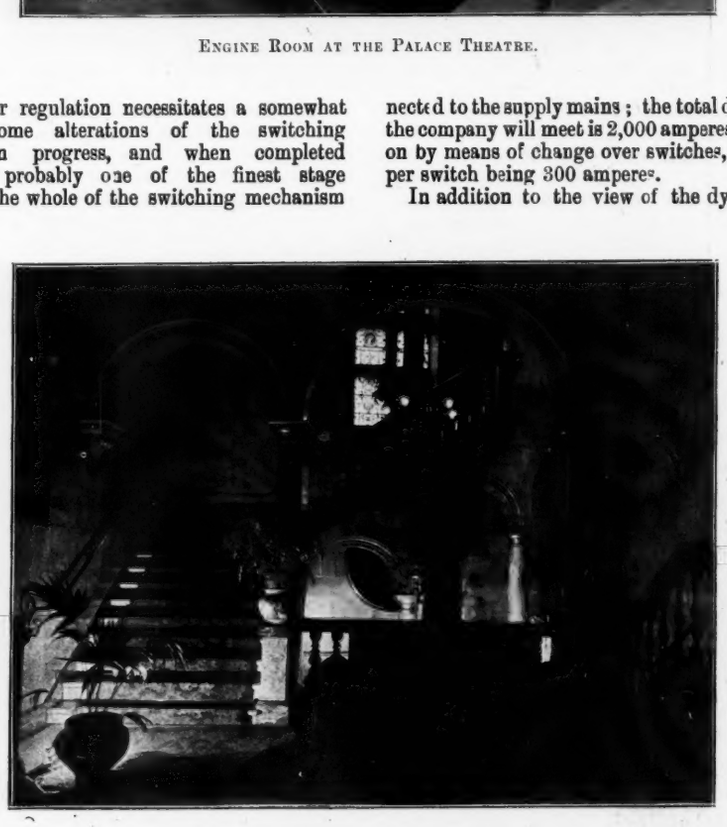
Engine Room at the Palace Theatre.

In a sense, the stage lighting is of the most importance, in so far as effects are concerned, and its proper regulation necessitates a somewhat elaborate board. Some alterations of the switching arrangements are in progress, and when completed the board will be probably one of the finest stage boards in London. The whole of the switching mechanism is placed at the right-hand side of the stage, at some distance from the ground, and from a special platform the footlights and the stage lights are controlled. The idea of the alternate circuits is carried out in the whole of the stage lighting. There are three sets of footlights arranged on alternate circuits, and the batten lights are connected in a similar manner. The lowering or dimming of the lights is a very important feature in the economy of stage management, and the alterations which are in progress include a set of liquid resistances. Up to the present, long lengths of platinoid wire have been utilised to give the necessary resistances, but these are now being done away with. The new scheme provides for a combined arrangement for dimming the entire front of the house; moreover, a new main break switch will put on circuits for stage effects, and it will be possible to produce sudden darkness in the house and the stage together by interlocking through a bar any of the switches it is desired to operate. The ancient limelight has been replaced by projector arc lamps, of which eight are in use, gas, as we have observed, being wholly tabooed throughout the building.

There are 10 arc lamps in front of the building, and the interior lighting consists of some 3,600 incandescent lamps, which are practically equivalent to 4,000 8-C.Ps. There are a number of ventilating motors fixed at different parts of the building, thus permitting the nicest regulation of the temperature of the building. Steam heating is used throughout the building, a system of live steam radiators being employed, as well as a bank of radiators heated by the exhaust steam from the engine, fresh air being drawn from the street and blown into the theatre by means of a Blackman fan.

As we have mentioned, the theatre is connected to the supply mains; the total demand, however, which the company will meet is 2,000 amperes, and this can be turned on by means of change over switches, the amount of current per switch being 300 amperes.

In addition to the view of the dynamos, we have reproduced two typical views of the Palace interior, one showing the method of lighting the *foyer*, and the other giving a view of the grand staircase from the vestibule. The method of lighting the latter is not clearly shown in the illustration, but it may be mentioned that the whole of the staircase is illuminated by means of rings of lamps arranged on a huge electrolier suspended from the ceiling.

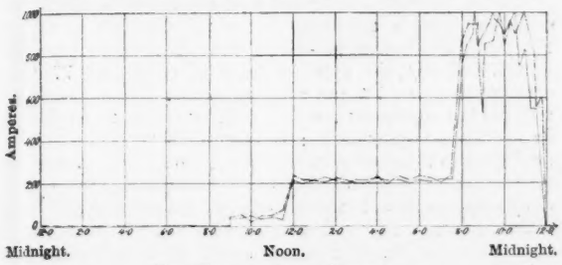


The Staircase at the Palace Theatre.

It is hardly necessary to observe that electrical stage effects at the Palace are frequent. At the present moment there is the Biograph, which bids fair to rival Tennyson's brook, and there have been the wonderful series of living pictures, and latterly Zieo and her electrical effects. As an indication of the demand for current that occasionally arises, it may be mentioned that one turn has required as much as 1,550 amperes.

A load curve cannot fail to be interesting, and some details as to cost will be useful. In 1897 the number of units gene-

rated was 234,798, coal and other fuel cost ·59d., oil, waste, stores, &c., ·11d., and wages ·613d., the total works' cost being 1·313d. A somewhat curious arrangement prevails in the running of the plant. The Palace Theatre Company owns the whole of the plant, but it is run under a contract by the Walsall Electrical Company, Limited, Mr. W. Slade Olver acting as their representative in London, the Palace



Two Typical Load Curves.

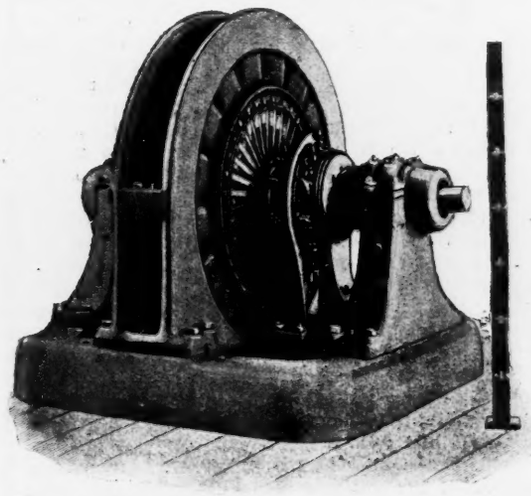
plant being under his direct supervision. We are indebted to Mr. Charles Morton and the management of the Palace, and Mr. Olver particularly, for the assistance given us in compiling the foregoing details.

THE LARGEST ROTARY CONVERTER EVER BUILT.*

In the station of the Pennsylvania Heat, Light and Power Company, Philadelphia, Pa., has recently been installed by the General Electric Company the largest 60-cycle rotary converter yet constructed. It is a 16-pole machine, of 400 kilowatts capacity, running at 450 revolutions per minute, and was designed to convert an alternating two-phase current of 60 cycles frequency, and voltage variable between 165 and 220 volts, into continuous current at from 225 to 300 volts. It is designated QC 16—400—450, and stands 8 feet high on a base 8 feet 4 inches by 8 feet 6 inches.

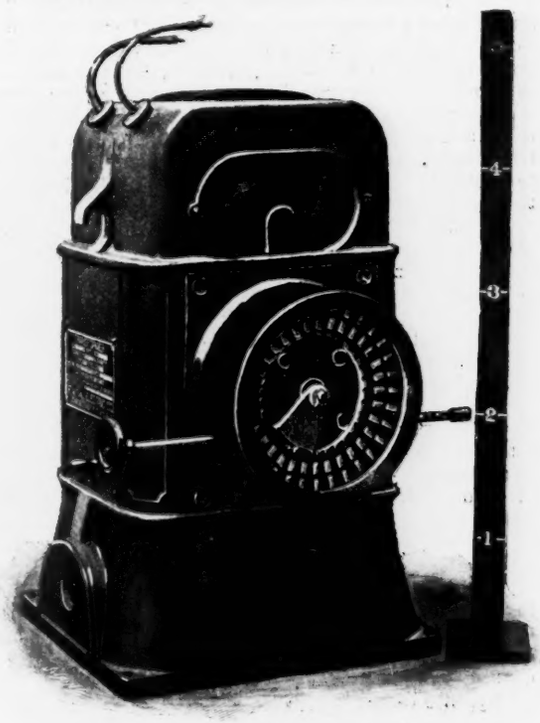
The field frame of this machine is heavily ribbed, divided horizontally, and susceptible of movement along the base to allow of inspection of the armature and field coils. The armature is of the ironclad type.

The commutator carried on a separate spider is of very ample service, and has a large number of segments. To facilitate the removal of a brush for examination, and replacement without varying the tension under which it runs, a brush-holder of unique design has been devised. To remove



2-Phase Side of 60-Cycle Rotary Converter.

the brush, the prolonged end of the brush-holder spring is disengaged from the brush-holder by a slight end motion. Another valuable feature in this machine is the design of the brush-holder studs and the method of attaching them to the yoke. The former—instead of passing through insulating bushings in the yoke, as has been customary in this type of machine—is provided with a lug bored to fit down upon a radial stud held by bolts passing through the insulating bushings. To slide the brush-holder stud off, it is simply necessary to loosen the nuts on the bolts passing through the bushings. By employing this method, all labour and expenditure of time usually consumed in removing the insulating bushings and washers from the brush-holder yoke to remove the stud are avoided, and the change can be effected in a very few minutes.



60-Cycle Transformer.

One of the illustrations shows the two-phase side of the converter. Upon the collector rings press numerous leaf brushes, having a long contact on the rings, and a very large current-carrying capacity.

To obtain the necessary variation in the continuous current of the rotary converter, the General Electric Company has furnished with it two special 60-cycle transformers, each of 220 kilowatts capacity. These have been designed to operate with a primary potential of 2,000 volts, and a secondary potential varying from 165 to 220 volts. The variation is obtained through a dial switch, over which passes a contact plate, cutting out or throwing in more or less turns of the primary winding, and thereby varying the secondary potential. The switch is operated by a wheel handle, and the potential may be varied rapidly in either direction, the contact plate snapping from contact to contact in one direction as well as in the other. The dial switch is applied to the transformer itself instead of being a separate device, and the entire construction is singularly compact.

* *Electrical Review* of New York.

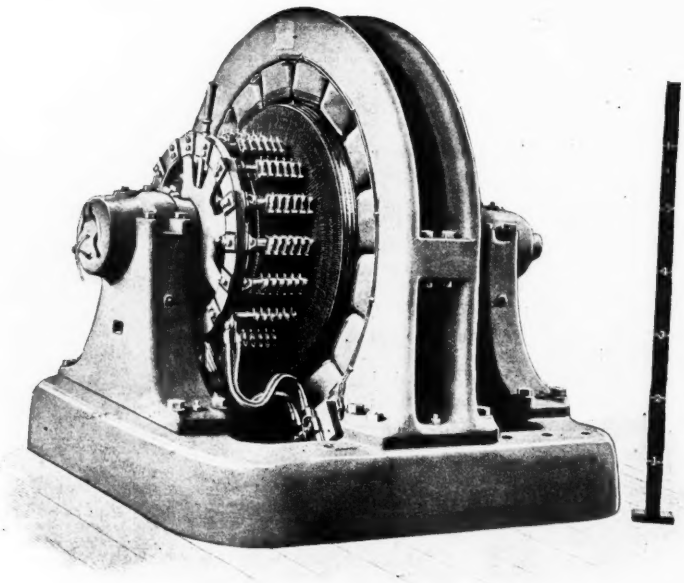
THE CONSTITUTION OF ALLOYS.

An article recently contributed by Mr. Albert Sauveur to the *Technology Quarterly*, entitled "The Constitution of Steel Considered as an Alloy of Iron and Carbon," treats incidentally of the recent developments of the theory of metallic alloys in general, according to which the structure is regarded as being controlled by the same laws that determine the constitution of mixtures of melted salts and of frozen saline solutions. The fact that alloys are solid at ordinary temperatures, while saline solutions are liquid, has alone delayed the recognition of this identity of character of the two classes of substances.

When common salt is dissolved in water, the freezing point of the water is lowered. By increasing the amount of salt, the freezing point of the resulting mixture is, at first, correspondingly lowered, until it contains a certain percentage of salt; further addition of salt raises the freezing point. The solution of lowest freezing point was called by Guthrie the "cryohydrate." If a solution poorer in salt than the cryohydrate is cooled, the temperature falls regularly, until the freezing point is reached; at this point, owing to the evolution of the latent heat of crystallisation of the ice, the rate of cooling is checked. Hence, a thermometer placed in the mixture indicates the temperature of solidification. The formation of pure ice causes the remaining liquid to become richer in salt, its freezing point is thereby correspondingly lowered; the deposition of ice, therefore, does not take place at a constant temperature, but proceeds as the temperature is further lowered. Meanwhile the remaining liquid becomes richer and richer in salt, until at last, at a certain constant temperature, it solidifies as a whole. The heat here evolved to balance the cooling is the latent heat of solidification of the cryohydrate.

A frozen saline solution, containing less salt than the cryohydrate, is made up of crystals of ice surrounded by the frozen cryohydrate. If the solution contains more salt than the proportion found in the cryohydrate, the thermometer indicates, at a certain temperature, an evolution of heat which marks the beginning of solidification, and corresponds to the formation of crystals of salt; these crystals increase in quantity as the temperature continues to fall. The remaining liquid becomes correspondingly poorer in salt, approaching more and more to the composition of the cryohydrate, which it reaches at a certain critical temperature. At this critical temperature the liquid solidifies as a whole, the temperature remaining constant until the entire mass is crystallised. The frozen mass is now made up of crystals of salt surrounded by the solid cryohydrate. These experiments show that while saline solutions, containing various proportions of salt, *begin* to freeze at temperatures that depend upon the degree of concentration, they all *finish* freezing at the same temperature for that salt, *i.e.*, the freezing point of the cryohydrate. By plotting these results, for a given saline solution, with percentage composition as abscissæ, and the temperatures at which the various mixtures freeze as ordinates, a V-shaped curve is obtained, having two straight branches meeting at a point corresponding to the freezing point of the cryohydrate. One branch of the curve represents the formation of crystals of ice in brines poorer in salt than the cryohydrate, while the other branch corresponds to the formation of crystals of salt in solutions richer in salt; hence the conclusion is almost irresistible that their meeting point corresponds to simultaneous deposition of ice and salt, and, therefore, that the frozen cryohydrate must be a mechanical mixture of ice and salt, probably in a state of minute division, outwardly having the appearance of a definite compound. Mixtures of melted salts that form neither definite compounds nor isomorphous mixtures, solidify according to the same law; they, too, have corresponding to them a mixture of definite composition and lowest melting point, which solidifies at a constant temperature. The salt which is present in excess solidifies first, until the composition of the molten mass reaches that of the mixture of lowest melting point. There is no need, therefore, to make distinctions between the solidification of aqueous saline solutions and that of mixtures of melted salts.

Mr. Sauveur proceeds to discuss mixtures of metals, and by the aid of curves he shows that the law of solubility of saline solutions is the same as that of fusibility of alloys. For instance, the copper-silver curve is composed of two branches of a V, the meeting point of which is at 770° C., corresponding to 72 per cent. of silver. This particular mixture has the lowest possible melting or freezing point of all silver and copper alloys; it is called the "eutectic," and is analogous to the cryohydrate of saline solutions. There are now two cases to be considered, for the composition of the alloy may correspond exactly to that of the eutectic, or it may differ from it. In the first case, as the mixture cools from a high temperature, it remains liquid until it reaches the solidification point of the eutectic, when it solidifies as a whole, at constant temperature. If, however, the composition differs from that of the eutectic, *i.e.*, if one of the constituents is present in excess with regard to that composition—the silver, for instance, in the silver-copper alloy—then when the cooling mass reaches a certain temperature, the silver in excess begins to solidify, exactly as did the water in the case of a saline solution. This deposition is accompanied by evolution of heat. The separation of pure silver continues until the portion remaining liquid has reached the composition of the eutectic. At this instant the silver is saturated with copper, the copper is saturated with silver, and both solidify at constant temperature. Alloys containing a larger percentage of silver than the eutectic are therefore made up of crystalline particles of silver in a matrix of the eutectic. Or if it be the copper which is in excess with regard to the composition of the eutectic, it is pure copper which begins to solidify when a certain temperature is reached in the cooling. Alloys of silver-copper containing a larger proportion of copper than the eutectic will therefore be made up of crystalline particles of copper surrounded by the eutectic.



Largest Rotary Converter.—60-Cycle Rotary Converter.

By the help of some extremely beautiful micrographs of sections, Mr. Sauveur shows that there is good reason to accept the modern theory of eutectics, *i.e.*, that they are merely mechanical mixtures of the constituent metals. Eutectics are seen to be made up of extremely minute crystals or plates, in close juxtaposition; for their resolution they often require very high microscopic power. They frequently present a brilliant play of interference colours.

We do not propose here to follow Mr. Sauveur into his discussion of the particular alloys of carbon and iron that constitute steel; our readers will do well to refer to the original paper if only to observe the magnificent examples of photo-micrography applied to sections of steel with varying proportions of carbon. Our purpose has been to draw attention to those parts of the paper which deal with the structure of alloys, a matter of the greatest importance to those who are interested in its electrical and mechanical qualities, and to those who are seeking an explanation of the

different behaviour of a pure metal and an alloy as regards electrical resistance at low temperatures. Additional evidence of the sub-divided structure necessary to Lord Rayleigh's theory of resistance is presented by the eutectics examined by Mr. Sauveur.

ELECTRIC LIGHTING NOTES.

(*Continued from page* 488.)

Weston-super-Mare.—It will be remembered that a week or so ago the Council decided by the casting vote of the chairman to apply for a provisional order for electric lighting. The ratepayers and opponents of the scheme have since met and passed resolutions against it, and copies of these resolutions will be sent to the Board of Trade and the Local Government Board.

Windsor.—In consequence of the great demand for electric light, the Windsor and Eton Electric Installation Company purpose next year increasing their plant by an engine and dynamo to supply 6,000 lights. The customers now number 130, as against 86 at the close of last year. The company also supply electric motors.

Wolverhampton.—The Lighting Committee of the Wolverhampton Corporation have under consideration a scheme for the extension of the electric light undertaking, involving a large capital expenditure, which it is proposed to submit to the Town Council next month. The scheme provides for the extension of the generating plant and distribution plant, at an estimated capital cost of £29,000, and this will meet all demands expected in the winter of 1899-1900. Having regard, however, to the extreme difficulty in obtaining electrical machinery, except upon long notice, owing to the congested state of the electrical industry, the committee desire the authority of the Council to forthwith obtain and accept tenders for one 300-H.P. steam dynamo set, and one combined battery charging and balancing set, the estimated cost of which is £3,200. This plant will form part of the £29,000 scheme, and it is considered very essential that no time should be lost in inviting and accepting tenders in respect thereof. Whatever schemes may be hereafter adopted, the above plant will, it is asserted, be an absolute necessity. Under these circumstances, the Council have given the necessary authority to the Lighting Committee. Owing to the steady and continued increase in the work of the electric lighting department, the collector of accounts has been transferred to the borough accountant's department. The chief offices of the department have now been removed from the Town Hall to the electricity works, Commercial Road.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Alpine Electric Railway.—According to a Dalziel despatch from Zurich, an English syndicate has been formed for the purpose of constructing an electric railway to connect Italy and Switzerland. The proposed line is to pass over the Great Saint Bernard Mountain from Aosta to Martigny, and is to be about 45 miles long. The cost is estimated at 15,000,000 francs.

Belfast.—The Electric Committee has unanimously passed the following resolution:—"That the Corporation be recommended to promote a Bill in Parliament for the laying and working of electric tramways in the City of Belfast, especially in those streets not already provided with a tram service, with power to acquire rights over any existing tramways within the city, and for all other purposes necessary for the establishment of an electric tram service in the city."

Broughty Ferry.—The Light Railway Commissioners sat at Dundee on 19th inst. for the purpose of taking evidence in connection with the application by the company promoting the light railway between Dundee, Broughty Ferry, and Barnhill. The Earl of Jersey presided, and was accompanied by Colonel Boughey. Several objections were lodged on behalf of the Joint Railway Company, but these were repelled, and witnesses were called. At the end of the evidence the chairman said the Court felt that the order came forward with the powerful support of the Corporation of Dundee and the Burgh Commission of Broughty Ferry, and therefore it would be granted. The term of years would be 25, and the agreements between Dundee and Broughty Ferry with the promoters would require to be carefully gone into. Mr. Addyman, on behalf of the promoters, accepted the terms as satisfactory.

Calcutta.—The Corporation has granted the Calcutta Tramways Company a new lease for 30 years. The company is at liberty to employ electric traction.

Chichester.—Mr. W. T. T. Chadwin, C.E., who is interesting himself in the promotion of the light railway from Chichester to Bognor, has been invited to attend an early meeting of the Chichester City Council in order to discuss the project.

Dartford.—The Board of Trade have intimated their approval of the Dartford and District Light Railway, the difficulties which were raised as to access to the Thames having been settled.

Huddersfield.—The matter of electric traction came up before the Town Council last week. The borough electrical engineer had reported to the Electric Lighting Committee upon the provision of additional plant for supplying electrical energy for tramcars on the Lindley, Edgerton, and Outlane routes, a length of 6·64 miles, by means of the overhead trolley system. He said the present electrical works were in a very good position if the whole tramway system was considered, and energy required by the Tramway Department would give the additional work required for the machinery in the day time. A further great advantage to the electric supply department would be that it would be possible to utilise the tramway mains supplying continuous current for the purpose of motive power to customers. He estimated the capital expenditure for buildings and plant at £31,500. The interest and sinking fund to repay that sum in 25 years would be £1,890 per annum. He estimated the costs chargeable to the Tramways Committee at 1d. per unit for generating, 1·63d. for interest and sinking fund, ·67d. for repairs, or a total of 3·30d. per unit. The Electric Lighting Committee adopted the report. The Committee also recommended that application be made to the Local Government Board for sanction to the Corporation to borrow £50,000 for machinery, mains, and other apparatus required for the supply of electricity. The Tramways Committee subsequently had the report of the electrical engineer before them, and referred it to their Electric Traction sub-Committee. In reply to questions, Alderman Haigh (chairman of the Tramways Committee) and Alderman Calvert (chairman of the Electric Lighting Committee) said it had not been absolutely decided to apply electric traction on the Lindley, Edgerton, and Outlane section of the tramways, that the proposal to ask for power to borrow £50,000 was contingent upon its being decided to run the cars on that section by electricity, and that the difference between the £31,500 and the £50,000 would be required for other extensions of the present electric lighting works. The minutes of the two Committees were then adopted.

Hull.—It is expected that the contract for relaying the track for the new electric tramways will be completed on November 1st.

Kirkcaldy.—The Electric Lighting and Tramway Committee are working energetically with a view to having their application for powers lodged in the ensuing session of Parliament. The tramway scheme is to connect with Dysart, instead of serving only the main thoroughfare of Kirkcaldy, and there is to be a returning route by the northern district of the town *vid* the new Den Bridge, the construction of which, at a cost of some £13,000, was recently agreed upon by the Town Council. The tramway will be on the narrow gauge principle, and the cars will be propelled by the overhead wire system. The first installation of the electric light is to apply to High Street. Should the anticipated success warrant, there will be further development of both schemes.

Liverpool.—Last Saturday the Light Railway Commissioners held an inquiry *re* the application for an order to construct a light railway from the city boundaries to Prescot, a distance of 3 miles 8 chains. It was explained that the object of the promoters of the scheme, the Lancashire Light Railway Company, Limited, was to have a continuous route of electric tramways from Liverpool dock to St. Helens and Prescot, the line at present proposed being intended to join with the Liverpool electric tramway when extended to the boundaries of the city. It was confidently expected that there would be a very large passenger and goods traffic.

When the City Council passed the scheme for an "experimental" electric tramline between St. George's Church and the Dingle, the cost was estimated at £50,000. The Tramways Construction Committee have, however, asked the Council for a supplementary £35,000, bringing up the total to £85,000.

Liversedge.—The District Council has had an interview in committee with a representative of a London firm of electrical engineers, who propounded a scheme for a service of electric tramcars between Dewsbury and the Spen Valley.

Newcastle.—The new Tramways Committee of the Newcastle Corporation having had under consideration the question of the Parliamentary Bill for 1899, have decided to recommend to the Council certain clauses for insertion in the said Bill regarding the tramways. The whole matter will come up for discussion at a full meeting of the Council to-day (Friday). The proposed additions practically provide for municipalisation. Among other things, the clauses include:—Power by agreement to purchase or take upon lease or form junctions with any authorised tramways outside the city, which form continuations of the lines existing within the city; provision that the Board of Trade may make provisional orders for the construction by the Corporation beyond the city; provision that the Corporation may use the lands for the purpose of generating electrical energy, and may thereon erect, construct, and maintain all such buildings, engines, dynamos, &c., as may be necessary and convenient for the generation, distributing, and tranforming and supplying electric energy for any purpose for which electric energy is by the Act authorised to be used or supplied. Provision is further made that if any of the tramways are worked by electricity, the Corporation shall have power to light by electricity the streets within the city, and all buildings, &c., where public money is spent for the lighting of the same.

Paisley.—On Tuesday last week the Light Railway Commissioners held an inquiry at Paisley into an application by the British Electric Traction Company, Limited, for a provisional order to authorise the laying down of light railways in the burgh of Paisley and district. Mr. Sydney Morse and Mr. Garcke were present for the company, and the Glasgow Corporation, Renfrew Authority, Paisley Corporation, the Caledonian Railway Company, the Govan Authority, Johnston Council, and other parties interested were represented. Mr. Morse explained the business and proposals of the company, and evidence was given in favour of the scheme by some of the authorities mentioned. Mr. Mackenzie, secretary of the Paisley Tramways Company, spoke to the Paisley Corporation having failed to exercise their option of purchase, and of the agreement made between his constituents and the British Electric Traction Company. He had considered the scheme before them. Even leaving out the line beyond the Paisley boundary to Glasgow, it would be a scheme of great importance to the general public. Mr. Garcke detailed the amount of labour which devolved upon him through preparing the scheme to meet the wishes of the Paisley Council. He was perfectly justified in saying that until lately he felt that he had all the local authorities with him other than the Glasgow Corporation. As a matter of fact, the town clerk was kept informed of all negotiations with the Tramways Company. He had great difficulty in getting reasonable terms from the Tramways Company, and he had to negotiate on the basis of securing them in their present position. The Tramways Company was not in a position to carry out a scheme of this kind, so he arranged that the Traction Company should carry out all negotiations and bear the expenses. The Traction Company did not think the undertaking was worth the money, but they were in the position of having a vested right, and they tried to give as much as the scheme could afford. There had been no objection by any members of Paisley Corporation to the preamble; every member expressed himself as being in favour of the extension of the tramways system. He knew the road from Paisley to Glasgow; there were no houses, and it would simply be through traffic. It would take a considerable amount of money to put down a double line along that road; in fact, it would be wasteful if the traffic did not call for it. There was a distinct moral understanding that the Paisley Corporation was in favour of the scheme. They were prepared to lay a double line through Paisley if such was insisted upon.

Mr. Balfour Browne opened the case for the Paisley Corporation. He said that Paisley had come to the conclusion that her lines were not worked efficiently, that they were not doing all that might be done by tramways in Paisley. They were most anxious to see tramways made, and had, therefore, at the time when the British Electric Traction Company came forward, considered the scheme very carefully. Although certain conditions were suggested, no definite arrangement had ever been come to, and no resolution had been made in the Council approving of the scheme. When the Corporation heard of the Glasgow scheme negotiations were opened, and a resolution was passed in favour of the scheme, and in opposition entirely to the Traction Company. His learned friend complained that they had only had very recent notice of these negotiations, but they had only been really completed the previous day by the Corporation of Glasgow. The whole of the negotiations between the Traction Company and Paisley were on the understanding that the tramways were to be carried to Glasgow, and the breaking off of that absolutely freed them from any obligation to this company, if they were under any.

The town clerk of Paisley gave an account of the negotiations which had taken place between the company and the Corporation, and observed that the line between Paisley and Glasgow was beyond all others the feature of the scheme. He still regarded it as the most important part of what was originally suggested. The Paisley Corporation finally decided to throw in their lot with Glasgow, and therefore to the full extent oppose the Traction Company's scheme. The Council were bound to accept what was best in the interests of the community.

After further evidence and argument, the Earl of Jersey, G.C.M.G. (chairman) said: We don't think that this Electric Traction Company has been dealt with in a fair and open way in this matter. They have been led on to suppose that they had the support of the Corporation of Paisley with regard to their proposals. That much is evident from what Mr. Garcke said in his evidence. It was said that the Corporation had changed their views, but I think they might have given earlier intimation to the company of the probable change of these views.

Mr. Balfour Browne: I should have preferred that they had given earlier information, but if your Lordship looks at the dates you will see very great difficulty in that.

Lord Jersey, in giving decision, said the Commissioners adhered to the view which they expressed a short time ago, that they were not prepared to go against the strong view of the Paisley Corporation against allowing tramways to be made within the boundary of Paisley by the British Electric Traction Company as suggested in the order. The application was therefore refused.

Mr. Morse asked that expenses be granted, but the Commissioners declined, Lord Jersey remarking that he sympathised with the company, and again commenting upon the unfair manner in which they had been treated.

All things considered we think it would have been only fair for the Commissioners to have allowed the promoters a portion of their expenses, the Paisley Council being made responsible.

The Paisley Tramways Company held an extraordinary general meeting on 21st inst., and passed a resolution extending the time allowed the British Electric Traction Company to withdraw from or confirm the agreement with regard to the tramways to December 22nd, 1898. The chairman said he regretted to some extent the way in which the company had been treated in this matter.

Scarborough.—A proposal is at present before the Town Council for the establishment of a system of 14 miles of electric tramways at Scarborough. There is not unanimity of feeling on the subject, and it is expected that the question will give rise to much controversy both in and out of municipal circles. A part of the scheme is to make a circular route of some six miles in extent.

TELEGRAPH AND TELEPHONE NOTES

The Amazon Cable.—We are informed that the ss. *Dona Maria* left Millwall Docks on Wednesday with 100 nautical miles of telegraph cable manufactured by Hooper's Telegraph and India-Rubber Works, Limited, for the Amazon Telegraph Company, Limited, to be laid in the River Amazon. The core consists of 7-strand copper conductor weighing 130 lbs. per nautical mile, insulated with an equal weight of Hooper's patent India-rubber, and sheathed with 12 No. 6 S.W.G. galvanised wires, and served and compounded to a total weight of 4¼ tons per nautical mile.

Pacific Cable Needed.—A Chicago daily paper published on August 24th, uses the following argument in favour of a Pacific cable:—"The flag-raising exercises took place at Honolulu on August 12th, yet it was not until yesterday that the fact was made known to the people of the United States. This demonstrates the necessity which exists for a cable connecting Honolulu with the American continent, in order that the Government and people of this country may keep in touch with their newly acquired possessions in the Pacific. A cable, extending not only to Honolulu but to the Asiatic coast, is one of the pressing needs emphasised by the war and by the annexation of the Hawaiian Islands. Congress must give its early attention to this matter."

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
West Indies—		
Barbadoes-St. Vincent...	Sept. 15th, 1898 ...	...
Santiago Caimanera ...	Sept. 27th, 1898 ...	...
Amazon Company's cable—		
Cable beyond Gurupa ...	June 8th, 1898 ...	...
Accra-Kotonou	Aug. 8th, 1898 ...	Sept. 27th, 1898.
Bolama-Bissao	June 31st, 1898 ...	...
Perim-Assab	Sept. 13th, 1898 ...	...
Seychelles-Maurice	Sept. 18th, 1898 ...	...
Landlines.		
Majunga-Tananarive ...	Sept. 19th, 1898 ...	...
Saigon-Bangkok	Sept. 27th, 1898 ...	

Telephone Pipes in the City.—At last week's meeting of the Court of Common Council the Streets Committee presented a report on the dispute between the Corporation and the Post Office authorities relative to the laying of telephone pipes without the permission of the former body. The committee submitted a letter from the Secretary of the Post Office intimating that the provision of wires between exchanges of the National Telephone Company and the houses of their subscribers was not contemplated. The letter further contained an assurance from the Postmaster-General that if his present policy should be departed from, he would not construct any telegraphs under consent of the Corporation within the city between the exchanges of the National Telephone Company and the houses of their subscribers without conveying to the Corporation an intimation that the policy had been changed. The committee stated that, subject to that understanding and to the usual condition that the contractors to the Corporation would be employed to make good the pavements disturbed, they had consented to the various applications of the Post Office authorities for permission to open the public ways.—The Court agreed with the committee in their report.

CONTRACTS OPEN AND CLOSED.

OPEN.

Ashton-under-Lyne.—October 3rd. The Corporation Market Committee is prepared to receive tenders for the installation of the necessary wires, fittings, &c., for the electric lighting of the public market. The current will be supplied from the town mains. Consulting engineers, Messrs. Lacey, Olirehugh and Sillar, 78, King Street, Manchester. See our "Official Notices" September 16th.

Belgium.—October 27th. The municipal authorities of Ghent are inviting tenders until October 27th for an installation of electric lighting in the new Flemish theatre in that town. Tenders to L'Hotel de Ville, Ghent, Belgium, from whence particulars may be obtained.

Dundee.—October 3rd. The Gas Commissioners want tenders for the supply of lead-covered cables and underground conduits. Specifications, &c., from Mr. W. H. Tittensor, city electrical engineer. See our "Official Notices" September 23rd.

General Post Office.—October 25th. The G.P.O. is inviting tenders (*a*) for the supply of red fir telegraph poles, to be delivered in London, and at Northumberland Dock (River Tyne), West Hartlepool, Hull, or Grimsby; and (*b*) for creosoting the poles with 10 lbs. or 12 lbs. of creosote to the cubic foot, as may be directed. The poles to be felled during the winter of 1898-9. Forms of tender, containing all particulars, may be obtained on application to Mr. Chas. E. Stuart, controller of stores.

Germany.—October 7th. Tenders are being invited by the Prussian State Railway authorities in Cologne for the supply of 11 tons of copper wire, 19 tons of galvanised iron telegraph wire, and half-ton of gutta-percha insulated wire. Tenders marked "Angebot auf Lieferung von Telegraphmaterialen," to be sent Die Konigliche Eisenbahr Direction, Cologne, from whence particulars may be obtained.

Ghent.—October 29th. The Ghent Municipal Council is inviting tenders for the installation of the electric light at a new theatre. The work, says *Daily Tenders and Contracts*, has to be completed by June 1st, 1899 (a fine being imposed for every additional day to completion), and maintained for 12 months. Labour clause. The contract includes the supply and delivery of 1,337 incandescent lamps, 20 arc lamps, &c. All expenses for registering, stamps, notices, &c., which are estimated to cost 130 francs, to be paid by the contractor. A deposit of 8,000 francs is required, on which 2 per cent. will be paid after 60 days. Specifications seen with, and plans obtained, on payment of 40 francs, from M. Le Sécrétaire Communal (A. De Bruycker), Gand, or at the office of the paper mentioned above. Tenders, on stamped paper, registered, addressed as directed, with a certificate of deposit, to be posted by October 27th. The tenders will be opened at 11 a.m. on October 29th.

Kingston-upon-Hull.— October 27th. The Electric Lighting Committee invites tenders for the supply and erection of certain plant in connection with the electricity works, including high and low tension mains, casings, trench work, &c.; switchboard, continuous current rotary transformers, motor-generator, &c.; centrifugal pump, condenser (ejector type), steam pipes, &c. Electrical engineer, Mr. A. S. Barnard. See our "Official Notices" September 23rd for particulars.

Kingston-upon-Hull.—September 30th. The Corporation wants tenders for the supply of 45 electric motor cars, 20 trailers, 2 sprinkler cars, and 2 traversing platforms. Specifications from Mr. White, city engineer. See our "Official Notices" August 19th.

Leigh.—October 14th. The Electricity Committee want tenders for the supply and erection of steam dynamos, switchboard, accumulators, mains, meters, overhead crane, water softener, &c., for the electricity scheme. Particulars from the engineer, Mr. John Foster, Leigh, Lancs. See our "Official Notices" September 23rd.

New South Wales.—October 17th. The New South Wales Government is, according to *Daily Tenders and Contracts*, inviting tenders for the supply for the Department of Posts and Telegraphs of a steam engine and dynamo, 218 tons galvanised iron wire, 90 tons copper wire, 70,000 porcelain insulators, 16,000 zinc cylinders, 16,000 lead ditto, 50 tons copper vitriol, 1,000 bottles ink for Morse instruments, 1,500 telephones, 1,000 batteries (Leclanché), 10,000 porous cylinders for same, 15,000 zinc ditto, 24 arc lamps, with 22,000 carbons, and 2,000 incandescent lamps. Further particulars, &c., obtained from, and tenders to, the Secretary, General Post Office, Sydney, N.S.W.

Plymouth.—October 6th. The Corporation want tenders for the supply of an enclosed (ironclad) continuous current motor, shunt wound, for 10 B.H.P. at 850—950 revolutions, for 520-volt circuit, complete with spare armature, starting switches, and resistances. Borough electrical engineer, Mr. J. H. Rider. See our "Official Notices" September 16th.

Portrane.—October 3rd. The Board of Control, Custom House, Dublin, is inviting estimates for the supply and erection of an electric light installation for Portrane Lunatic Asylum, County Dublin. See our "Official Notices," September 9th, for particulars.

Rathmines and Rathgar.—October 5th. The Electric Lighting Committee is inviting tenders for the supply and erection of Lancashire boilers, mechanical stokers and other boiler house plant, also high speed steam dynamos, condensing plant, overhead traveller, switchboard, underground cable work, cables, posts for incandescent street lighting, street lanterns, and incandescent lamps and meters. Consulting engineer, Mr. Robert Hammond. See our "Official Notices," September 9th, for further particulars.

Spain.—October 3rd. Tenders are being invited by the municipal authorities of Almagro (Ciudad Real) for the concession for the electric lighting of the town. Tenders to be sent to El Secretario del Ayuntamiento de Almaguo (Ciudad Real), Spain, from whence particulars may be obtained.

CLOSED.

Chiswick.—The District Council received three tenders for the installation of electric light at the pumping station. The contract was given to Messrs. Lawrence & Butcher, who quoted £175 10s.; Messrs. Warburg & Dymond quoted £264 8s. 8d., and Messrs. Thornycroft £280.

NOTES.

The Nernst Lamp.—It appears that considerable alarm has been caused among the German electrotechnikers by the coming of the new Nernst glow lamp, which is about to be brought out by the Allgemeine Electricitäts Gesellschaft. They fear that the value of existing installations may be depreciated if their tension is not suited to that of the lamp of the future. Prof. Nernst has, however, written a letter to the editor of *Elecktrotechnische Zeitschrift*, which ought to reassure them. The professor writes:—"Your note has given me a welcome opportunity to answer numerous inquiries which have reached both the A.E.G. and myself about the progress of the electrolytic glow lamp. We are of opinion that it would not be advisable to publish any details before our experiments are completed, and we can arrive at a sound decision about it. We can, however, at the present stage, be certain that the lamp will be supplied to the public in a form suitable for use with existing electric installations (100—220 volts, continuous or alternating current). It will not therefore be necessary to delay the execution of projected installations until the lamp appears, nor need the owners of existing installations have any fear that the introduction of this lamp will put them out of date. These lines may perhaps contribute to allay the fears that have been entertained by many on this question." If the invention is anything like so important as the inventor's letter would lead us to suppose, a revolution in incandescent lighting must be at hand. Nernst's English patent (No. 23,470, of 1897) has just been published, but gives very few more particulars as to the construction of the lamp than have already been published. The method of heating the incandescent body involves the use of a wire made of a refractory electric conductor, such as platinum. Three ways of employing this are given, the heating coil being in each case in a separate circuit. In the first the wire surrounds the incandescent body permanently, and is itself surrounded by a transparent, refractory, insulating substance. Both of these systems necessitate that the circuit of the coil be switched off by hand when the material to be incandesced becomes a conductor. In the third method the refractory material is attached to an iron plunger, sliding in a coil, which is connected in the main circuit. As soon as the body becomes a conductor, a current flows through the latter coil, which draws in the plunger, and at the same time draws the body from the heating coil, and actuates a switch which cuts the current off from the heating coil. The materials indicated in the specification are magnesia, zirconia, lime, and other oxides of metals, or such materials as are non-conductors at ordinary temperatures, but become conductors when heated to a high temperature.

Liquid Air.—A Bray paper brays as follows in a recent leading article:—

> Almost every European nation claims in its turn to have added some new page to the advance of science through one of her great men. The latest important laurel claimed under this head passes to America. Through all time it has been held that the air which we breathe resisted all efforts to reduce it to a liquid state. The crown, which fair science plants upon the brow of him who wrests from nature some of her most hidden secrets, this time falls to Prof. Charles Tripler, of America.

This Irish contemporary evidently does not believe in that commonplace maxim: "Honour to whom honour is Dewar."

Tramway Deputations.—With reference to a recent report issued by a provincial tramway deputation to the Continent on the subject of electric traction, *Engineering* says:—"The self-denying way in which the councillors of our provincial towns spend their time in investigating Continental systems of tramways is really remarkable. We fancied that after the report issued by the City of Glasgow they would be content to take their knowledge at second-hand, but their local patriotism seems to impel them to investigate everything for themselves. It would be very interesting to learn what view the foreign bureauratic officials take of these proceedings." We wonder what our contemporary will say to the proposal of the City of Glasgow to investigate the matter yet once more!

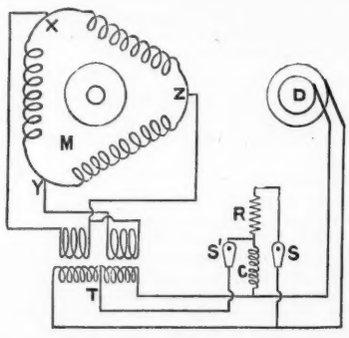
Electrical Accidents.—Two accidents recently happened one after the other on the same system (alternating current at 2,400 volts), the first at Puteaux and the second at Garches. In the first locality is a station from which electricity is distributed throughout the surrounding neighbourhood. The first accident happened in the following manner on July 28th:—A fire broke out at some India-rubber works, a wooden beam caught fire, and in falling brought with it the electric wires which were fixed upon it and which were conveying the current. The wires in falling touched a workman, who was killed; two other workmen, on going to the assistance of their comrade, were also killed. On August 8th at Garches, during a storm, some trees and some posts supporting electric wires carrying current at 2,400 volts were overthrown. A gardener of Montretout was killed while trying to shift a post which was obstructing his garden. As regards the first accident, it seems to us that at the time of installation care should have been taken to render it impossible for a beam to fall upon electric cables. Moreover, at the commencement of the outbreak notice should have been sent to the electrical station to cut off the current. Lastly, assuming that the duties of the first workman necessitated his being at the spot where the cables fell, the two others ought not to have touched them. When there is a dangerous installation in any establishment, the workmen ought all to be warned of the danger, and, above all, to be told what to do in case of accident. Formal instructions to this effect should be drawn up. With regard to the second accident, we cannot understand how after a storm which had evidently caused serious disturbances in the distributing circuit the company should not have turned off the current with a view to remedying the damage that had been done. It is most important in electrical installations, especially those using high tensions and alternating currents, to take every precaution as soon as possible.—J. L. (*L'Industrie Electrique*).

A Far Eastern Crisis!—A few days ago, says the *Kobe Chronicle*, the telegraph company coolies at Shanghai struck for an advance of wages. They refused to deliver the messages, and Mr. J. Heuningsen, the general manager, had 11 of them arrested. The next day they were brought before the Mixed Court, when Mr. F. S. A. Bourne, the British Assessor, stated that it was a serious thing for public servants, such as telegraph clerks, &c., to strike, and they should not do so. Two of the ringleaders were given 50 blows upon the hand with a heavy ruler in the Court room, whereupon the others cried out that they would go to work again, and were thereupon let off with a caution. We are afraid such a method does not recommend itself for extensive application in dealing with English strikers, who are generally supposed to stand on a higher level of civilisation than the Chinese coolies.

Moribund Manhattan and Electric Lifts.—In the above we have the opinion of the *Electrical Engineer*, of New York, of the elevated railways of that city. It has become so by reason of the competition of electrical cars at the street level. At one time the elevated line carried over half a million passengers daily—in fact, at times of particular holidays, we believe over 700,000 have been carried. Now it is said the line has lost its short distance traffic. Our contemporary gives no figures of the traffic, but states that 22,000 extra fares per day would pay interest on the, at most, £2,000,000 required to introduce electricity. It is curious that the inside railways of the world's two biggest cities should both be in a state of decay for lack of courage to embark in electrical traction. Electricity on the trains and elevators at the stations to lift at least the feebler and wheezy passengers to platform level are looked on as certain remedies for the dry rot of the Manhattan. While on the subject of lifts, is it not time to protest against the absence of passenger lifts at all our London stations? No matter where one goes, be it Broad Street or Ludgate and St. Paul's, in the City, or the numerous suburban stations, which, with few exceptions, are all either up high stairs or down, as at Harringay, there is no provision for the aged or the weakly. We know, as a fact, aged people frequently forego journeys because of the stairs, and nowhere is the evil worse than in London. Occasionally a steep slope is provided, as at Stroud Green, but this is nearly as bad as a stair, for it involves energy expenditure at a rapid rate—a feat outside the sphere of practical physics for many people. Some of the New York elevated stations are very high up, and many passengers avoid them for this reason alone, and use the surface cars; and the same thing occurs in London, where people patronise the 'bus in preference to undertaking an arduous stairway. But with easy grades and electricity the passengers would be secured. Is not this proved by the strange emptiness of the 'buses to Waterloo, which may be seen running more or less empty inside from Blackfriars since the opening of the electrical railway. If railways will not adopt electricity they will simply lose their business.

Since the foregoing was written we are interested to observe the announcement in the daily press that Mr. George Gould has stated that electricity will shortly be substituted for steam power on the Manhattan Elevated Railway of New York. If this statement be correct, it is pregnant with interest, for it evidently means that the company finds that steam traction does not pay, and intends trying electricity. As mentioned above, the line is losing traffic steadily, and, worse still, it has piled up a floating debt of over a million dollars. Its quarterly traffic reports are going from bad to worse, and it was recently thought that electricity would place things upon a better footing, and enable the line to regain its lost traffic. The cost of electrical equipment has been put at from eight to ten million dollars, and we presume this is the proposal which Mr. George Gould announces is to be adopted.

Phase Transformers.—The usefulness of some simple form of phase transformer enabling single-phase currents to be split up into polyphase currents, and thus permitting the use of a simple conducting system of one wire, would be especially appreciated in the field of railway work, where any attempt to use polyphase currents for power purposes is met at the outset with the difficulty of a double trolley system. In a very valuable paper in *Zeitschrift für Elektrotechnik* Herr Gustav W. Meyer discusses all the forms of phase transformers with special reference to this application. An ingenious device for operating a three-phase motor on a single-phase current supply is illustrated. The motor, M, has the usual field winding and a three-phase winding on its rotor. The stator is connected as shown to the two ends and the middle point of the secondary of an ordinary split transformer, and in the primary circuit with this is connected a



non-inductive resistance, R, and a self-induction coil, C, as shown. By the switches, S and S', these can be cut in or out of the circuit. At starting they are cut in, as shown, and produce a sufficient displacement of phase to start the motor. After the motor attains speed the switches are opened and the reaction of the three-phase winding on the rotor induces a current in the part X Y of the stator winding, the machine continuing to run as a three-phase motor, though supplied with single-phase current. The *American Electrician* says that it is claimed that this method surpasses the rotary phase transformer of Arnó and Ferraris on account of its simplicity and cheapness and absence of moving parts.

The Chemical Action of the Electric Spark.—Berthelot has recently investigated the reactions which occur when various alcohols, &c., are submitted for a lengthened period to the influence of electric sparks in an atmosphere of nitrogen. The following are the conclusions:—1. All the alcohols examined fix nitrogen, yielding bodies of an aimdo or basic nature. 2. At the same time hydrogen is evolved in the case of the Cn $H_2n + 20$ alcohols, methyl alcohol giving off one atom and ethyl and propyl alcohols, two atoms of hydrogen. 3. This loss of hydrogen is comparable with the decomposition suffered under similar conditions (also in the absence of N) by CH and CH, which split off two atoms of carbon. Allyl alcohol, however, yields up comparatively little hydrogen, resembling, in this respect, acetylene and allylene. 4. The phenols fix nitrogen in proportion varying greatly in individual cases. 5. The phenols evolve only traces of hydrogen, a circumstance noteworthy in respect to quinol, which so readily parts with 2H in many reactions. 6. Alcohols of the fatty series fix nitrogen at the rate of one atom for every 2H evolved, *i.e.*, (see 2) two mols. of methyl, or one mol. of ethyl or propyl alcohol, fix one atom of nitrogen. As regards allyl alcohol, three mols., fix N_2. 7. Comparing the ratio of C to N in the compounds formed from the alcohols and corresponding hydrocarbons respectively, this ratio is the same for methane and methyl alcohol; whilst ethane (or ethylene) and propylene fix only half as much N as the respective alcohols. Allyl alcohol fixes more N than allylene, the ratios being in the proportion of 3 : 5. 8. In the case of isomeric bodies, the C : N ratio is the same for propyl and isopropyl alcohols, as also for propylene and trimethylene. The three dihydric phenols differ so widely in their behaviour, that no conclusions can be drawn. 9. As regards structure, it is probable that these nitrogen compounds are aldehydric condensation products, possessing a cyclic constitution, resembling that of the pyridine and quinoline bases. The original paper may be consulted in the *Comptes Rendus*, 126, 616.

Tractive Resistance on Tramways.—The *Railway World* gives the following figures of tractive resistances on tramways:—The average pull required per ton of load to keep a car moving is 30 lbs. With exceptionally clean rails, as during a heavy rainfall, and with the rail grooves void of dirt, the pull may be as low as 20 lbs. per ton, or below this figure, approximating to the 10 or 12 lbs. of railway work. Again, a very dirty, clogged rail, may demand more than the 30 lbs. Multiplying the pull by the speed in feet per minute gives the power in foot-pounds, so that the horse-power is simply

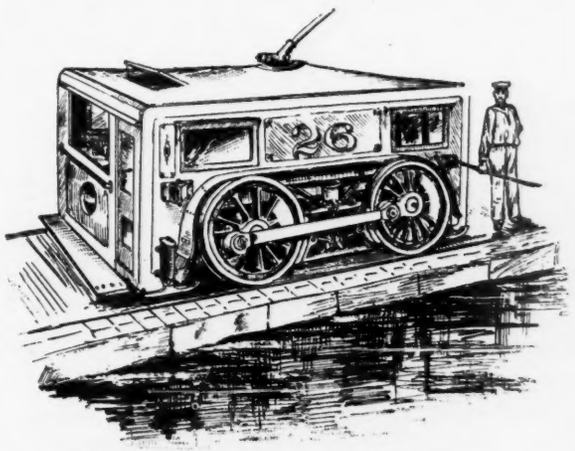
$$\text{H.P.} = \frac{\text{T} \times \text{W} \times \text{S}}{33{,}000},$$

where T is the pull per ton necessary, W is the load in tons, and S the speed in feet per minute. This rule gives the horse-power on the level. To find the power on a grade, the vertical rise of the car is found by dividing the speed of the car in feet per minute by the length of road in which there is a rise of 1 foot. The number of feet of vertical lift multiplied by the total weight in pounds is the measure of the work done against gravity, or, $\frac{\text{S} \times \text{W}}{\text{F}}$, where W is the load, S is the speed, and F is the distance, in which the road rises 1 foot. Thus on a 1 in 30 grade, F = 30. The addition of the two results gives the total horse-power.

Lectures.—A course of 12 lectures on "Electro-Chemistry" will be given at the University College, London, by Profs. Hudson Beare, Fleming, and Ramsay. The course begins on November 24th. Prof. Fleming will also deliver 10 lectures on "Electrical Measurements," commencing on October 10th, and Prof. Beare will deliver 20 lectures and conduct laboratory work in "Mechanical Engineering," commencing on October 14th. For particulars as to terms, &c., see our "Official Notices" this week.

A special short course of six lectures on "Electro-Optics" is announced to be given by Prof. Silvanus P. Thompson, at the Finsbury Technical College, on Thursdays, beginning October 6th.

Electrical Canal Traction.—An American experimenter has been granted permission to try electrical traction on the Miami and Ohio Canal. If successful he is to have the exclusive right for 25 years of all electrical traction work on this canal which is 250 miles long. It would thus appear that the canal owners being too timid to make the tests themselves of what must be a success, are prepared to put the canal into the hands of a monopoly for 25 years, and so possibly defeat the very object they have in view, the keeping up and, indeed, re-establishing of the canal, which has fallen very much into decay. The proposer is a Mr. Wagenhals, and here is a picture of this motor which is



Electric Locomotive for Canal Traction.

to run upon rails laid on the tow path. A speed of six miles per hour is found practicable by experiment, and an ordinary motor towed a couple of boats, each loaded with 80 tons, at 10 miles velocity, but this was too fast and damaged the banks. Mr. Wagenhals's motor is to weigh, says the *Street Railway Review* (to which we are indebted for our figures) no less than 20 tons, though only 6 feet over all. As the canal is only 60 feet wide and 4 feet deep, the motor seems to us enormously heavy. Let us suppose that to tow an ordinary barge at six miles per hour requires eight horses. One horse will tow a barge at two miles per hour, so that we have cubed the ratio of speeds. Eight horses will represent, say, 400 lbs. of pull at six miles per hour, a horse being taken equal to about 26,000 foot-pounds per minute. If one-fifth of the load on the wheels can be taken for adhesion this would give 2,000 lbs. as the weight of the motor, so that a 2-ton motor ought to do easily the draught of two boats. Possibly the 20 tons is a misprint for some smaller figure. Mr. Wagenhals expects the working expenses to be $95,000 per annum. The present earnings are $190,000, so that there will be $95,000 to pay profits on the estimated cost of $850,000 necessary to equip the canal between Dayton and Cincinnati on which distance the above earnings were made.

Circuit Breakers v. Fuses.—It is becoming customary to use circuit breakers instead of switches to open and close main circuits, this probably being due to the fact that it is easier to trip the trigger of a circuit breaker than to pull out a heavy switch. This practice, says the New York *Electrical World*, although prompted by laziness, is to be commended, as the carbon brake of the circuit breaker removes the arc from the main contacts to a point where it does no harm. Double pole circuit breakers, made up in such a way that the two sides can be independently closed, require no switches in series with them, since the first pole restored acts as a safety when the second is closed, unless double-throw or change-over connections have to be made in the circuit. Even in this case the circuit breaker can always be opened in ahead of the switch, eliminating the arc from the switch contacts. It might be well for the manufacturers of this type of apparatus to get up double-throw, single, double, or triple pole circuit breakers, which could be used in place of the present circuit breakers and switches.

The American Tool Trade.—If Americans can make anything, we think that light machine tools are their specialty. In heavy work so far they lack artistic feeling. Compare, for example, their good but hideous locomotives with our own, and again, the flimsiness of even an American 9-inch lathe with the more business-like build of an English lathe. But come to small tools, and the Americans are seen at their best. The president of the Gisholt Machine Company, a well-known American house, writes in *Modern Machinery* on the effect of the war upon American trade. This we may dismiss as off the point, seeing that Americans at present hang every excuse upon the war peg. But Mr. Johnson only speaks the truth when he states that European shop proprietors are, as a rule, not practical men. There is, as we have of late taken frequent opportunities of saying, far too much nepotism about our English shops. While this is natural in a country like ours, where so many shops were started about a century ago, it puts us at present at some disadvantage—a disadvantage which in due time will attach to American shops and to German shops, in neither of which country are there many important shops founded prior to 1860 to 1870. At the same time, Mr. Johnson both understates and overstates his case. We doubt whether our best shops in England of later foundation, especially such as, say, Herbert's, of Coventry, would take second place to any American shop. Like other Americans who have begun to think, our author is troubled about the tariff, and is in a terrible fear of tariffs being put up against America in Germany, and he has even the grace to admit that the ridiculously high American tariff needs revision. Curiously enough, he wants America to keep free of foreign complications by giving up the Philippine Islands to Great Britain. America is not to charge for them, but to give them to us free, and we, on our part, are to placate Germany in the matter by another graceful concession. How would the Isle of Wight do? Poor, long-suffering Great Britain only wants to be asked, and she will grant America the free use of every harbour she owns in the world. Why, then, asks our author, should America worry over naval stations when Great Britain is so handy as a chestnut puller? But we turn over a leaf, and find that all this is to have some compensation. A manifest destiny is to bring all the North American Continent under one flag. Mr. Johnson is a bold man to advocate one flag for all North America. We ourselves have long thought that such a consummation would be to the best interests of all concerned. We heartily reciprocate Mr. Johnson's feelings, and look to the day when the "flag that never lost its grip" waves from Pole to Panama. What millions of dollars America would save every fourth year!

Electrical Power on Shipboard.—The *American Electrician*, in an article by Mr. F. W. Roller, points out that not only is the economy of electricity so very great, but the multiplicity of steam and exhaust pipes constitutes a danger greater than that of shot and shell. Recent tests on the *Minneapolis* showed even 300 lbs. per H.P.-hour for some pumps, and this is obviously a most serious cause of limiting the range of a warship. Even larger auxiliary engines use as much as 110 lbs. per hour per H.P. Further, electricity enables ventilating fans to be placed in their proper compartments in place of requiring the cutting of bulkheads for air ducts, and another danger, that of sinking, is minimised. At most the steam consumption per H.P. applied to a motor as current would be 30 lbs. per hour. On the *Minneapolis* the auxiliary engines consume a fourth of all the steam used. They ought, of course, to exhaust into the low pressure casing of the main engines, but here again there would be long exhaust pipes, and an enormous weight of water in the steam. By means of electricity about 70 per cent. of the auxiliary fuel may be saved, and we see no reason why the exhaust should not now go to the main L.P. casing if not condensed in its own plant. Multiphase induction motors are recommended as best able to stand rough usage. They can be worked by simply adding three or four collector rings, according to the system adopted, to the ordinary direct current generator, and taking off the current there by stationary brushes to the motors. While adding but little to the complication at the generator end, this would make matters very simple at the motor end, where probably less skill will be available than at the generators.

Presentations.—Mr. E. Cross, of the Bradford Corporation Electricity Department, has been appointed assistant to Mr. J. A. Bell, the city electrical engineer at Aberdeen, and on Saturday last he was the recipient of a very handsome writing desk, which had been subscribed to by the whole of the staff. The presentation was made in the station by Mr. E. Wright, and friends representing the various departments of the works expressed good wishes for the future.

On Friday last Mr. D. M'Leod, the assistant at the Aberdeen Corporation Electricity Works, was presented with a smoker's cabinet and two engineering books on the occasion of his leaving the station to become manager to some Dublin manufacturing works.

Electrical Stage Appliances.—The *Times* says that Mr. Edwin Sachs is at present engaged in arranging for an installation of electricity with a view to changing scenes by electrical power at Drury Lane Theatre. By the new arrangement large sections of the stage floor (measuring 40 feet by 7 feet) can be raised to any level above or below the stage, individually or together, by simply working an ordinary switchboard. The installation, which is undertaken by the Thames Ironworks, will be ready for the coming pantomime.

Bad Wiring at Buenos Ayres.—The *Review of the River Plate* says:—"The tricks of the electric light wiremen (as they are pleased to call themselves) in this city are numerous. We have heard of one who did not believe in prepared tape for covering the joints, but made his own by dipping bits of old rag in paraffin. Another excused himself, when it was discovered that half the joints were not soldered, on the plea that he had not had time; but he had found enough time to cover over all the joints with tape, and he waxed wroth when an engineer told him what he thought of him and his work. The excuses made for low insulation are numerous and varied, but no wireman has ever yet acknowledged that this is due to scamped work. There is such a boom in electric light work now, that everybody is going into the business, but many will retire with burned fingers and dearly bought experience."

The Thermophone.—In the Electrical Review, Vol. xlii., p. 393, we described some remarkable experiments by Simon, which went to show that the electric arc was capable of acting equally well as a telephonic transmitter or as a receiver. Prof. Braun, of Strassburg, has recently published * an investigation into this phenomenon, which shows that the sensitiveness of all apparatus acting on this principle is considerably increased when the oscillating current is superimposed on a constant current. A current of periodically varying intensity, i, generates in time $d\,t$ in a resistance r, a quantity of heat represented by $i^2\,r\,d\,t$. If the amplitude of the current, which is supposed to be small, is i_0, the greatest possible variation of the temperature is proportional to $i_0^2\,r$. If now we suppose a current variation, $d\,\mathrm{I}$, superimposed on a large constant current, I, then the variation of the joule heat under like circumstances is $2\,\mathrm{I}\,d\,\mathrm{I}$. $d\,\mathrm{I}$ is here $= i_0 \sin 2\,\pi\,n\,t$, and the maximum temperature variation is, therefore, proportional to $2\,\mathrm{I}\,i_0\,r$. From this we see that, with i_0 constant, we can make the variations as great as we please by increasing I. It is also evident from these equations that, in the first case, the original note is given out as an octave, while in the second case it is given out as exactly of the same pitch. Braun's experiments completely confirmed the predictions of this theory. A bolometer grating was used as the telephone, the sound given out being intensified by a collecting funnel. When the small varying current of the secondary of an induction coil was sent through the grating no sound was heard, but when a steady current of 0·06 to 0·12 was superimposed on this, the sound was distinctly heard. When a bolometer was arranged in circuit with four accumulators and a microphone speech, loud and distinct, was given out by the bolometer. Mr. Preece was the first, in 1884, to describe an instrument of this kind, but Braun has not been able to ascertain whether he superimposed a constant current on his telephonic current or not.

* *Wied. Ann.*, 65, p. 358.

Economical Steam Working.—Prof. Aldrich, in the *American Electrician*, expresses the opinion that American practice in steam will favour, in the near future, higher pressure rather than superheating. One of his reasons is that to add 100° to the steam as superheat will take less fuel than to raise it to the pressure corresponding to the same temperature, though in the latter case there is the necessity of providing extra strength of parts. He admits that the best economy is that which is attained when there is no cylinder condensation; the walls must be dry at the point of release, and he points out the great importance of dryness, in opposition to the use of high pressures of mere saturated steam. Dryness can be obtained by superheating, while higher pressure gives more expansion, and he might have added greater wetness, too much expansion not being by any means an altogether desirable thing. The reasonable superheat will, he thinks, really secure a dry release; there must be some external provision, and he looks on the jacket as able to afford this, or the intermediate reheater which, of course, may be also a superheater. He thus sets out the conditions at which he would aim. In simple engines, jackets and slight superheat. In compound and triple engines the same, with reheating receivers. In no case must steam be admitted wet, even where not actually superheated. In existing plants an outlay on a superheater or economiser will result in a gratifying return. Scarcely any plant need go short of reheating receivers, these being so easy to apply, and it will always be economical to raise pressures and reduce the size of the high pressure cylinder in proper proportion. The crucial fact in economy is the dry cylinder at the point of release. American practice, so far, has stopped at casual superheating, and superheaters proper have been usually abandoned. To be really effective, a superheat of 100° to 300° is demanded, so as to give a true steam gas. American engine builders prefer not to jacket their cylinders, but will do so on request. When made, there is a provision, as a rule, to feed the jackets through a reducing valve, thereby giving the operator the power to operate them at a disadvantage. It is, of course, sheer nonsense to feed a jacket with reduced steam. Rather there should be a separate jacket boiler at a higher pressure. Finally, he advocates the cross compound engine with reheater, as the most satisfactory means of driving a generator, which may so conveniently be placed between the two cylinders, except, in the case of vertical engines, which may damage the generator by drippings, and in such case the dynamos are placed on the shaft ends which overhang.

Fire Insurance Rules.—The Liverpool and London and Globe Insurance Company has just issued its "special risks" supplement of electrical installation rules. These supplements will be issued from time to time, dealing especially with the particular precautions which are shown by experience to be desirable. The present risks for which rules are given are warehouses for the storage of produce, corn, textile, and oil mills, theatres and music halls, central electric lighting stations, and drying stoves.

Local Authorities and Electric Lighting.—The *Times* says that Lord George Hamilton, M.P., has forwarded the following letter to the Acton District Council, which had asked him to oppose the Bill promoted in the last session of Parliament by the General Power Distributing Company. The Bill, as will be remembered, excited much opposition among local authorities which had taken up electric lighting orders, or were proposing to do so:—"India Office, Whitehall, S.W. Sir,—I have to acknowledge the receipt of your letter of July 22nd. I am in favour of local authorities having control over the lighting in their districts, and, where practicable, applying the profits of such enterprise to the reduction of the rates of the locality. On the other hand, private enterprise will often develop experiments and initiate improved methods of lighting which the local authority may not be able to conduct themselves, and it is by the combination of the two methods that the community at large may be most benefited. The Bill to which you call my attention is postponed till next session, and I shall be glad when it comes up in a new shape to hear what the views of the Acton District Council are."

Micro-structure of Alloys for Bearings.—The *Mechanical World* reprints a paper read before the Franklin Institute, by Mr. G. H. Clamer, on "The Micro-structure of Bearing Metals." The author points out the advantages to be derived from a microscopical examination of the texture of alloys, as a check upon the foundryman's work. It frequently happens that an alloy of good composition is rendered inefficient by faulty manipulation, the mixture being uneven and granular. A skilled foundryman will often make a better metal from inferior scrap. Moreover, the wearing qualities can be predicted from the micro-structure of alloys; a bearing metal which is finer in granular structure will wear the slower, because of the tearing off of smaller particles. In considering the question of cost of maintaining machinery, the expenses are directly dependent upon the wearing qualities of the alloy and its successful use as scrap; the alloy must have the quality of retaining its qualities after re-melting. For obtaining the best surface for microscopic examination, the method of Guillemin is recommended. The specimen is first polished and then etched electrolytically by exposing it for a few minutes in a bath of very dilute sulphuric acid when connected with a single Daniell cell. A set of 12 micro-photographs of sections treated by this process accompany the paper. In conclusion, the author gives some useful information with regard to the structure and composition of "babbitt" metal. The first white metal successfully used for bearings was invented by Isaac Babbitt. It contained tin, antimony and copper. All white metals used for bearing purposes are now sold in the States under the name of "babbitt" metal, and when used as a lining, the bearing is said to be "babbitted." But to distinguish this metal from the cheaper lead alloys it is classed as "genuine babbitt"; it is harder than lead alloys, much tougher, is finely crystalline, and wears well. Owing to the proportion of tin, it is rather expensive. Practical tests show that an alloy of copper-tin-lead gives better results, so far as anti-frictional qualities are concerned, than copper-tin-lead-phosphorous; moreover, it is found by experience that remelted phosphor-bronze is much more liable to give hot bearings than the newly-made metal. The phosphorous in bronze takes the form of phosphides, which high temperature can drive out only in small proportions. After re-melting, the micro-structure becomes decidedly crystalline, whereby its anti-frictional and wearing qualities are greatly reduced. The metal, after the tenth re-melt, can scarcely be touched with a file.

Municipal Telephone License for Glasgow.—It is stated that the Corporation of Glasgow has received a letter from the Postmaster-General stating that he will be prepared to give them a license for a telephone exchange on their securing the requisite powers from Parliament for working an exchange system. A condition of the license is, that it will expire December 31st, 1911.

Babcock Boilers at Boston.—The Babcock & Wilcox boiler seems to be exceedingly popular in Boston, U.S.A. That this is so is seen from the statement made in the New York *Electrical Engineer* that at the West End Street Railway Company power stations (five in number) 19,000 H.P. of these boilers is used, while the Lynn and Boston Street Railway has 4,000 H.P., the Edison Electric Illuminating Company, 4,000 H.P., and the Boston Electric Light Company's new station will have 4,400 H.P. when completed. Such a showing does credit to the Babcock boiler and to the Babcock & Wilcox Company.

Owen's College.—On Tuesday afternoon next, October 4th, the foundation of the new physical laboratory at Owen's College, Manchester, will be laid.

Society of Engineers.—Before this Society on Monday, October 3rd, Mr. S. Cowper-Coles will read a paper on "Protective Metallic Coatings for Iron and Steel."

Appointment.—Mr. Maurice G. Temple, M.A., of Coatbridge electric lighting station, has been appointed assistant electrician on the cable staff of the Anglo-American Telegraph Con pany.

Accident on the Waterloo and City Line.—The *Daily Chronicle* says that on Wednesday morning, on the quarter past 10 train on the electric railway from Waterloo to Mansion House, the brake failed to act upon arrival at the City end, and the train ran beyond the platform into the tunnel, and then came into collision, putting out all the lights, and giving the passengers a violent shaking.

NEW COMPANY REGISTERED.

Paris Singer, Limited (58,878).—This company was registered on September 21st, with a capital of £100,000 in £10 shares, to acquire the business carried on by Paris E. Singer at Clapham, and by Ernest Archdeacon at Suresnes, near Paris, and at the Avenue de la Grande Armee in Paris, to manufacture, sell, and deal in gas, oil, electrical and other engines, cycles, motors, motor cars, &c., and to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity, &c. The subscribers (with one share each) are:—H. V. Higgins, 28, Bedford Row, W.C., solicitor; H. W. Stickland, 80, Riggindale Road, Streatham, solicitor; G. D. Horton, 129, Florence Road, Wimbledon, clerk; H. L. Pring, 34, Cambrian Road, Richmond, S.W., accountant; R. M. Campbell, 19, Klea Avenue, Clapham Common, manager; M. B. Shaw and A. Reeves, 165, Manor Street, Clapham, S.W., clerks. The number of directors is not to be less than three nor more than five; the first are Paris E Singer, Frederick R. Cheeswright, and Robert J. Beadon; qualification, one share; remuneration as fixed by the company. Registered office, 165, Manor Street, Clapham, S.W.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Chili Telephone Company, Limited (29,252).—This company's annual return was filed on August 30th, when 44,000 shares were taken up out of a capital of £250,000 in £5 shares, and paid for in full.

Electric Construction Company, Limited (39,292).—This company's annual return was filed on August 23rd. The capital is £400,000 in £2 shares (50,000 preference); 25,000 preference and 110,000 ordinary have been taken up, and 13,145 of the former and all the latter are considered as paid; £2 per share has been called, and £23,710 paid on the remaining 11,855 preference shares.

Jandus Arc Lamp and Electric Company, Limited (43,898).—This company's annual return was filed on August 20th, when 2,041 shares were taken up out of a capital of £30,000 in £10 shares; 596 are considered as paid, and £5 per share has been called on the others, resulting in the receipt of £7,225.

Improved Electric Glow Lamp Company, Limited (47,636).—This company's annual return was filed on September 14th, when 74,270 shares were taken up out of a capital of £100,000 in £1 shares; 34,270 are considered as paid, and £40,000 has been paid on the others.

CITY NOTES.

Buenos Ayres and Belgrano Tramways Company, Limited.

An extraordinary general meeting was held on 22nd inst. at the offices, Moorgate Street, Mr. J. B. Concanon presiding, to consider a resolution for winding up the company voluntarily.

The Chairman, in proposing the resolution, remarked that the meeting was purely formal. Its object was to enable them to wind up the old Buenos Ayres and Belgrano Company, and to distribute among the shareholders the shares of the new Buenos Ayres and Belgrano Electric Company.

Mr. J. Anderson seconded the motion, which was carried unanimously.

The Chairman afterwards stated that they would have to hold another meeting, which would be called as soon as possible, and then the shareholders would receive their shares in the new undertaking. They were proceeding as rapidly as they could with the equipment and construction of Mr. Bright's line, and they were also engaged almost daily in considering the reconstruction of their own line with electrical equipment. The directors had no reason to change the opinion held by them at the outset—that when the line was converted to one on which electric traction was employed, it would show them a very handsome result. Probably some of them might be shareholders in other Buenos Ayres tramway companies, and they might have heard opinions expressed by the chairmen of some of those concerns to the effect that, as horses and forage were cheap in Buenos Ayres, they did not see their way to make any change. That, however, was not the case of this company. They had a clean sweep from Belgrano—Bright's line—right into the very heart of the city, and there were no narrow streets as far as that part of the system was concerned. They would run a rapid and good service to Belgrano, which was a very important and rising suburb of Buenos Ayres, and with such a service he felt convinced that they would be well repaid. The conditions of other companies in Buenos Ayres were somewhat different from this company's, the lines of the former being almost entirely within the heart of the city, and in comparatively narrow streets. In answer to a question, the chairman added that, as regarded stopping stations, they would have to consider the feeling of the majority of their passengers. Generally on the Continent, and in some places in this country—Leeds, for instance—stopping places had been decided on, in order to get over the journey more quickly. The people had to go to these stopping places, but in Buenos Ayres he doubted whether the passengers would care to walk even 100 yards to a stopping station. Their cars, however, would be able to run very quickly, and they could be so easily stopped that passengers could be picked up at any point.

Brazilian Submarine Telegraph Company, Limited.—The directors have, after transferring £25,000 to the reserve fund, decided to recommend a final dividend of 3s. per share, making with previous distributions, a total dividend of 6 per cent. for the year ended June 30th, 1893, and also the payment of a bonus of 2s. per share, both free of income-tax. The balance of the account, subject to audit, is carried forward. For the purpose of paying the above dividend and bonus on October 27th, the register of transfers will be closed from October 18th to the 26th, both days inclusive.

Anglo-American Telegraph Company, Limited.—The directors have resolved, after placing £6,000 to the credit of the renewal fund, to declare an interim dividend for the quarter ending September 30th, 1898, of 15s. per cent. on the ordinary stock, and £1 10s. per cent. on the preferred stock, less income-tax, payable on November 1st, to the stockholders registered on the books of the company on September 30th, 1898.

The Direct United States Cable Company, Limited.—The board has resolved upon the payment of an interim dividend of 3s. per share, free of income-tax, being at the rate of 3 per cent. per annum, for the quarter ending September 30th, 1898, such dividend to be payable on and after October 24th next.

Eastern Extension Telegraph Company.—The directors have declared an interim dividend for the quarter ended June 30th last of 2s. 6d. per share, free of income-tax, payable on 15th prox.

Castner-Kellner Alkali Company, Limited.—The directors have declared an interim dividend at the rate of 8 per cent. per annum for the six months ending 30th inst.

TRAFFIC RECEIPTS.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending September 23rd, 1898, were £2,992 16s. 6d.; corresponding period, 1897, £2,584 1s. 10d.; increase, £408 14s. 8d.

The City and South London Railway Company.—The receipts for the week ending September 25th, 1898, were £926; week ending September 26th, 1897, £891; increase, £35; total receipts for half-year, 1898, £12,314; corresponding period, 1897, £11,694; increase, £620.

The Dover Corporation Electric Tramways.—The receipts for the week ending September 24th, 1898, were £216 12s. 6d.; week ending September 25th, 1897, £132 2s.; increase, £84 10s. 6d.; total receipts to September 24th, 1898, £6,207 9s. 8d.

The Dublin United Tramways Company.—The receipts for the week ending September 23rd, 1898, were as follows:—D. U. T. Co., horse cars, £2,410 11s. 7d.; ditto, electric cars, £460 2s. 4d.; D. S. D. Co., electric cars, £1,041 8s. 11d.; total, £3,912 2s. 10d.; corresponding week last year—D. U. T. Co., horse cars, £2,784 8s. 4d.; D. S. D. Co., electric cars, £563 0s. 9d.; total, £3,347 9s. 1d.; increase, £564 13s. 9d.; aggregate to date, £54,207 18s. 11d.; aggregate to date last year, £49,898 13s. 2d.; increase to date, £4,309 5s. 9d.; the mileage open is 13 miles electrically, 31 miles by horses, as against 8 miles electrically, and 34 miles by horses, for the corresponding period last year.

The Liverpool Overhead Railway Company.—The receipts for the week ending September 25th, 1898, amounted to £1,680; corresponding week last year, £1,407; increase, £273.

The Western and Brazilian Telegraph Company, Limited.—The receipts for the week ending September 23rd, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,062.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, Sept. 21st.	Closing Quotation, Sept. 28th.	Business done during week ended Sept. 28th. 1898. Highest.	Lowest.
137,400l	African Direct Telegraph, 4 % Debs.	100	4 %	...	...	100 —104	100 —104	102½	100½
25,000	Amazon Telegraph, shares	10	...	...	...	6 — 7	6 — 7	...	...
125,000	Do. do. 5 % Debs. Red.	100	...	...	...	92 — 95	92 — 95	...	...
923,960l	Anglo-American Telegraph	Stock	£2 9s	£2 13s	3 %	63 — 66	63 — 66	...	...
3,038,020l	Do. do. 6 % Pref.	Stock	£4 18s	£5 6s	6 %	115½—116½	115½—116½	116½	115½
3,038,020l	Do. do. Deferred...	Stock	...	...	...	15⅝— 16½	15⅝— 16½	16½	15⅝
130,000	Brazilian Submarine Telegraph	10	7 %	7 %	7 %	15¾— 16¼	15¾— 16¼	16⅛	15¾
75,000l	Do. do. 5 % Debs. 2nd series, 1906 ...	100	5 %	...	...	112 —116	111 —115	112½	112
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	4 %	4 %	2¾— 3¼	2¾— 3¼	...	...
10,000,000$	Commercial Cable	$100	7 %	8 %	8 %	180 —190	180 —190	...	...
918,297l	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	105 —107	105 —107	106¼	105¼
224,850	Consolidated Telephone Construction and Manufacturing	10/-	1½ %	2 %	...	1/16— 1/16	1/16— 1/16	...	...
16,000	Cuba Telegraph	10	8 %	8 %	7 %	8½— 9½	8½— 9½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	15 — 16	15 — 16	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	...	...
30,000l	Do. do. 4½ % Debs., Nos. 1 to 6,000 ...	50	4½ %	4½ %	4½ %	103 —106%	103 —106%	...	...
60,710l	Direct United States Cable	20	2½ %	2½ %	...	11½— 12	11½— 12	11⅞	11⅝
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	100 —103	100—103	101	...
400,000	Eastern Telegraph, Nos. 1 to 400,000	10	6½ %	6½ %	7 %	17⅜— 18¼	17⅜— 18¼	18	17 13/16
1,295,000	Do. 3½ % Pref. Stock	100	...	...	...	105 —108	105 —108	106¼	105
40,000	Do. Prov. Certs., 50 % paid	...	...	...	...	...	52 — 55	...	...
89,900	Do. 5 % Debs., repayable August, 1899 ...	100	5 %	5 %	5 %	100 —103	100 —103	...	...
1,302,615l	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	126 —130	126 —130	127	...
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	17½— 18	17½— 18	18	17⅞
25,200l	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	5 %	5 %	99 —103	99 —103	...	...
100,500l	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	5 %	5 %	100 —103	100 —103	...	...
320,000l	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	125 —129	125 —129	125½	...
35,100l	Eastern and South African Telegraph, 5 % Mort. Deb., 1900 red. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	...	99 —103	99 —103	...	...
46,500l	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	...	100 —103	100 —103	...	...
300,000l	Do. 4 % Mort. Debs., Nos. 1 to 3,000, red. 1909	100	4 %	4 %	...	102 —105	102 —105	104	102½
200,000l	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	4 %	4 %	...	104 —107%	104 —107%	...	...
180,227	Globe Telegraph and Trust	10	4⅛ %	4⅛ %	4⅛ %	12 — 12½	12 — 12½	12⅜	12⅛
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6 %	16⅜— 17¼	16⅜— 17¼	17⅛	16 13/16
150,000	Great Northern Telegraph, of Copenhagen...	10	10 %	10 %	10 %	29 — 30	28½— 29½	29⅛	...
160,000l	Do. do. do. 5 % Debs. ...	100	5 %	5 %	5 %	101 —104	101 —104	...	...
97,000	Halifax & Bermuda Cable, 4½ % 1st. Mt. Dbs., w'n. 1-1,200, rd.	100	...	...	...	100 —104	100 —104	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	51 —54	51 — 54	...	...
100,000l	London Platino-Brazilian Telegraph, 6 % Debs. ...	100	6 %	6 %	6 %	110 —113	109 —112	110	...
28,000	Montevideo Telephone, 6 % Pref., Nos. 1 to 28,000 ...	5	4 %	4 %	4 %	2¼— 2¾	2¼— 2¾	...	...
484,597	National Telephone, 1 to 484,597	5	5½ %	5½ %	6 %	5⅝— 5⅝	5⅝— 5⅝	5 9/16	5⅝
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13 — 15	13 — 15	13½	13
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	13 — 15	13 — 15	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5⅜— 5⅝	5⅜— 5⅝	...	...
1,329,471l	Do. 3½ % Deb. Stock Red.	Stock	3½ %	3½ %	3½ %	100 —105	100—105	103	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅝— ¾	⅝— ¾	...	...
100,000l	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	4 %	4 %	105 —108	105 —108	...	...
11,839	Reuter's	8	5 %	5 %	5 %	8 — 9	8 — 9	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	136 —141	136 —141	...	...
58,000	United River Plate Telephone	5	4 %	5 %	6 %	4¼— 4⅜	4¼— 4⅜	...	...
146,733l	Do. do. 5 % Debs.	Stock	5 %	...	...	103 —106	103 —106	...	...
15,609	West African Telegraph, 7,501 to 23,109	10	4 %	*nil*	*nil*	3½— 4½	3½— 4½	...	...
213,400l	Do. do. 5 % Debs.	100	5 %	5 %	5 %	99 —102	99 —102	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	¼— ¾	¼— ¾	...	...
150,000	Do. do. 4% Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	104 —107	104 —107	...	...
64,269	Western and Brazilian Telegraph	15	3 %	2 %	3½%	12 — 12½	12 — 12½	12⅜	12⅛
33,129	Do. do. do. 5 % Pref. Ord.	7½	5 %	5 %	5 %	8 — 8½	8 — 8½	8½	...
33,129	Do. do. do. Def. Ord.	7½	1 %	*nil*	½%	4 — 4½	4 — 4½	...	...
389,521	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	107 —110	107 —110	...	...
88,321	West India and Panama Telegraph	10	½%	1 %	½%	1 — 1½	1 — 1½	1	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	6 %	6 %	9¼— 9⅜	9¼— 9⅜	9½	9⅜
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	6 %	6 %	6 — 8	7 — 9	7¾	...
80,000l	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	5 %	105 —108	105 —108	...	...
1,163,000$	Western Union of U.S. Telegraph, 7 % 1st Mort. Bonds	$1000	7 %	7 %	7 %	105 —110	105 —110	...	...
160,100l	Do. do. do. 6 % Ster. Bonds ...	100	6 %	6 %	6 %	98 —103	98 —103	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electricity Supply	5	5 %	6 %	7 %	12 — 13	12 — 13	12 1/16	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	6¼	...
26,000	*Chelsea Electricity Supply, Ord., Nos. 1 to 10,277... ...	5	5 %	5 %	6 %	9 — 10	9 — 10	...	...
60,000	Do. do. do. 4½ % Deb. Stock Red....	Stock	4½ %	4½ %	4½ %	113 —115	113 —115	114½	...
50,000	City of London Electric Lighting, Ord. 40,001—90,000 ...	10	5 %	7 %	10 %	24½— 25½	24½— 25½	25⅜	...
10,000	Do. Prov. Certs. Nos. 90,001 to 100,000 £5 ...	10	...	...	...	24 — 25	24 — 25	...	...
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16½— 17½	16½— 17½	...	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	125 —130	125 — 130	128	127¾
30,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—30,000	10	*nil*	*nil*	*nil*	13 — 14	13 — 14	13⅛	...
10,000	Do. do. do. Nos. 30,001 to 40,000 £6 paid.	10	...	...	...	8½— 9½	8½— 9½	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	14 — 15	14 — 15	14¾	...
17,400	Edmundsons Elec. Corp., Ord. Shares 1—17,400	5	...	...	5 %	5 — 5½	5½— 5⅞	...	...
10,000	House-to-House Electric Light Supply, Ord., 101 to 10,100	5	...	...	4 %	9 — 10	9 — 10	...	...
10,000	Do. do. 7 % Cum. Pref. ...	5	7 %	7 %	7 %	9½— 10½	9½— 10½	...	...
62,400	*Metropolitan Electric Supply, 101 to 62,500	10	4 %	5 %	6 %	17 — 18 xd	17 — 18	17¾	17⅛
220,000l	Do. 4½ % First Mortgage Debenture Stock	...	4½ %	4½ %	4½ %	116 —120	116 —120	119	118½
6,452	Notting Hill Electric Lighting	10	2 %	4 %	6 %	15½— 16½	15½— 16½	...	...
31,980	*St. James's and Pall Mall Electric Light, Ord.	5	7½ %	10½ %	14½ %	17 — 18	17 — 18	18	17⅝
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 10	9 — 10	9½	9⅛
50,000	Do. do. 4 % Deb. Stock Red. ...	Stock	...	...	4 %	105 —108	105 —108	...	...
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2⅞— 3⅛	2⅞— 3⅛	3	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000 ...	5	7 %	9 %	12 %	16 — 17	16 — 17	17	16

* Subject to Founder's Shares.
‡ Unless otherwise stated all shares are fully paid.
† Quotations on Liverpool Stock Exchange.
‖ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation Sept. 21st.	Closing Quotation Sept. 28th.	Business done during week ended Sept. 28th, 1898. Highest.	Lowest.
60,000	Aluminium "A" shares, Nos. 1—60,000	1	...	...	...	2¾— 3	2⅞— 3⅛	...	...
90,000	Do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	96 —102	96 —102	...	...
30,000	British Electric Traction	10	...	...	...	16½— 17	16½— 17	...	...
10,000	Do. do. 6 % Cum. Pref. 30,001—40,000 (issued at £2 10s. prem. all pd.)	10	...	...	...	13 — 14	13 — 14	13⅜	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	2½%	*nil*	*nil*	1⅜— 2 xd	1⅜— 2	1 11/16	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	*nil*	4 %	2⅛— 2⅜xd	2⅛— 2⅜	2⅜	2¼
125,000*l*	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	107 —111	107 —111 xd	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red. ...	Stock	...	...	...	102 —105	102 —105	104½	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000 ...	5	...	...	...	10 — 11	10 — 11	...	...
90,000	Do. do 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	110—113	110 —113	...	...
19,894	Central London Railway, Ord. Shares	10	...	...	...	10 — 10½	10 — 10½	10⅜	10½
129,179	Do. do. do. £6 paid	10	...	...	...	6 — 6½	6 — 6½	...	...
59,254	Do. do. Pref. half-shares £1 paid ...	...	...	...	...	1¼— 1⅜	1¼— 1⅜	...	...
67,680	Do. do. Def. do. £5 paid ...	...	...	...	...	4½— 5	4½— 5	...	...
630,000*l*	City and South London Railway	Stock	1 3/16 %	1 9/16 %	1⅝ %	70 — 72	70 — 72	71	70½
22,500	Do. do. Ord. shares, Nos. 1 to 22,500 £3 pd.	10	...	...	...	2⅜— 3¼	2⅜— 3¼	...	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	...	...	1⅜— 2¼	1⅜— 2¼	...	...
82,850	Do. 5% 1st Mort. Reg. Debs., 1 to 743 of £100, and 901 to 1,070 of £50 Red.	...	...	...	...	89 — 94	89 — 94	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	5 %	5⅛%	6 %	2¼— 2¾	2¼— 2¾	...	...
17,139	Do. do. do. "A" Shares, 01—017,139	5	5 %	5⅛%	6 %	4 — 5	4 — 5	...	...
194,023	Do. do. do. 4 % Deb. Stock Red. ...	100	...	...	...	101 —103	101 —103	...	...
110,000	Electric Construction, 1 to 110,000	2	5 %	6 %	6 %	2¼— 2⅜	2⅛— 2⅜	...	...
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 ...	2	7 %	7 %	7 %	2⅜— 3¼	2⅜— 3¼	...	...
111,100	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	105 —107	105 —107	...	...
91,196	Elmore's Patent Copper Depositing, 1 to 70,000	2	...	...	...	⅜— ⅝	⅜— ⅝	...	...
67,275	Elmore's Wire Manufacturing, 1 to 69,385, issued at 1 pm.	2	...	...	...	¼— ½	¼— ½	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	10½%	7 %	7 %	10 — 12	10 — 12	...	...
12,500	Henley's (W. T.) Telegraph Works, Ord.	10	8 %	10 %	12 %	20½— 21½	20½— 21½	21½	...
3,000	Do. do. do. 7 % Pref.	10	7 %	7 %	7 %	18 — 19	18 — 19	18¼	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½%	4½%	4½%	110 —115	110 —115	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	10 %	22½— 23½	22½— 23½	23¼	22¾
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	103 —107	101 —105 xd	105	...
37,500	†Liverpool Overhead Railway, Ord.	10	2⅞%	2⅞%	3¼%	10 — 10¼	10 5/8 — 10 7/8	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15½— 16	15½— 16	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	39 — 43	39 — 43	...	...
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	100 —103	100 —103	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	...	...	126 —131	125 —130	128½	126½

† Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 10⅛.
British Aluminium, Ordinary, 10½—11½; 7 % Pref., 12—13.
House-to-House, 4½% Debentures of £100, 106—109.
Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 14—15; 1st Preference Cumulative 6%, £5 (fully paid), 7¾—8¼. Debentures, 107—109. Dividend, 1897, on Ordinary Shares 10%.
London Electric Supply Corporation, £5 Ordinary, 3¾—4.
National Electric Free Wiring, 10s. paid, ⅜—½.
*T. Parker, £10 (fully paid), 13—13½.
Yorkshire House-to-House Electricity, £5 Ordinary Shares fully paid, 7⅜—8¼. Dividend for 1896—6%.

* From Birmingham Share List.

Bank rate of discount 3 per cent. (September 22nd, 1898).

MARKET QUOTATIONS, Wednesday, September 28th.

CHEMICALS, &c.		This week.	Last week.	Increase or Decrease.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a „ Nitric	per cwt.	22/-	22/-	..
a „ Oxalic	per cwt.	32/-	32/-	..
a „ Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per ton	37/-	37/-	..
a Ammonia, Muriate (grey) ..	per ton	£19	£19	..
a „ „ (white) ..	per ton	£26	£26	..
a Bleaching powder	per ton	£6 15	£6 15	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£14 10s.	£14 10s.	..
a Benzole (90 %)	per gal.	7/-	7/-	..
a „ (50/90 %)	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£17	£17	..
a Lead, Nitrate	per ton	£23 10s.	£23 10s.	..
a „ White Sugar	per ton	£30 10s.	£30 10s.	..
a „ Peroxide	per ton	£27 10s.	£27 10s.	..
a Methylated Spirit	per gal.	2/9	2/9	..
a Naphtha, Solvent (90 % at 160° C.)	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks ..	per lb.	3½d.	3½d.	..
a „ Caustic (75/80 %) ..	per ton	£24	£24	..
a „ Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	64/-	64/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6 10	£6 10	..
a „ Recovered	per ton	£5 10	£5 10	..
a „ Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£8 15	£8 15	..
a „ Crystals	per ton	£3	£3	..
a „ Bichromate, casks ..	per lb.	3d.	3d.	..

METALS, &c.		This week.	Last week.	Increase or Decrease.
b Aluminium Wire, in ton lots ..	per ton	£224	£224	..
b „ Sheet, in ton lots ..	per ton	£191	£191	..
c Brass (rolled metal 2° to 12°) basis	per lb.	6½d.	6½d.	..
c „ Tube (brazed)	per lb.	8½d.	8½d.	..
c „ Wire, basis	per lb.	6½d.	6½d.	..
f Ebonite Rod	per lb.	3/-	3/-	..
f „ Sheet	per lb.	5/-	5/-	..
g Copper Bars	per ton	£62	£62	..
g „ Wire (basis price) ..	per lb.	7½d.	7½d.	..
g „ Sheet	per ton	£62	£62	..
g „ Rod	per ton	£62	£62	..
n German Silver Wire	per lb.	1/6	1/6	..
h Gutta-percha, fine	per lb.	5/6	5/6	..
h India-rubber, Para fine ..	per lb.	4/- forw'rd	4/1½ forw'rd	1½d. dec.
i Iron, Charcoal Sheets	per ton	£18	£18	..
i „ Pig (Cleveland warrants)	per ton	43/4½	43/-	4½d. inc.
i „ Forgings, according to size	per ton	From £11	From £11	..
i „ Scrap, heavy	per ton	45/-	45/-	..
i „ Wire galvanised No. 8 ..	per ton	£8 15	£8 15	..
g Lead, English Ingot	per ton	£13	£13	..
g „ „ Sheet	per ton	£13 17 6	£13 17 6	..
l Mica	per lb.	5/6	5/6	..
m Manganin Wire No. 28.. ..	per lb.	8/-	8/-	5/1. ..
g Mercury	per bottle	£7	£7 9	9s. dec.
o Platinum	per oz.	£2 16	£2 16	..
i Steel, Magnet, according to description	per ton	From £15	to £40	..
i Steel, Magnet, in bars		£58	£58	..
g Tin, block	per ton	£76 10	£76 10	..
g „ foil	per lb.	1/3	1/3	..
j Yarns, Cotton, Single 10lb. bundles	per lb.	6½d.	6½d.	..
j „ Flax, 6 or 8 lea... ..	per lb.	3½d.	3½d.	..
j „ Hemp, 3 ply 10 lbs. ..	per lb.	3½d.	3½d.	..
j „ „ Russian, 10 lbs.	per lb.	4½d.	4½d.	..
j „ Jute, 180 lbs. rove ..	per ton	£11 10	£11 10	..
j „ Manila, 24 thread ..	per ton	£31	£31	..
k Zinc, Sheet (Vielle Montagne brand)	per ton	£26	£26	..

a Quotations supplied by Messrs. G. Boor & Co.
b „ „ „ The British Aluminium Co., Ltd.
c „ „ „ Messrs. Thos. Bolton & Sons.
d „ „ „
e „ „ „
f „ „ „ The India-Rubber, G.-P., and Teleg. Works Co. Ltd
g „ „ „ Messrs. James & Shakespeare.
h „ „ „ Jackson & Till.
i Quotations supplied by Messrs. Bolling & Lowe.
j „ „ „ „ Henry C. Yeo & Co.
k „ „ „ „ Morris Ashby, Limited.
l „ „ „ „ Sanders, Wake & Co.
m „ „ „ „ W. T. Glover & Co., Ltd.
n „ „ „ „ P. Ormiston & Sons.
o „ „ „ „ Johnson Matthey & Co.

THE ADDRESS TO THE BRITISH ASSOCIATION, MECHANICAL SCIENCE SECTION.

SIR JOHN WOLFE BARRY in his address said very little that can be usefully abstracted, it dealing generally with ships, harbours, and docks; but one little item may be noted more particularly. He strikes a note of warning against *ex cathedra* utterances and prophecy based upon ill-considered data and hasty generalisation. Tredgold, for example, considered that bridges should be designed for a wind pressure of 40 lbs. per square foot, such a pressure having been shown by a board 1 foot square. Then when the Tay Bridge fell in 1879, the Board of Trade called for 56 lbs. on the whole exposed area to be provided for. Yet experiments at the Forth Bridge with two gauges, one of 300, the other of 1½ square feet area, showed that the large board registered 38·7 per cent. less unit pressure than the small board. The Tower Bridge bascules again, where a gauge showed 6 to 9 lbs. per square foot, only registered on this area of 5,000 square feet from 1 to 1½ lbs., as shown by the working of the actuating engines. He deplores the waste caused by the building of bridges for 56 lbs. wind pressure. We believe this pressure is still the standard in America for an unloaded bridge, and about 30 lbs. for a loaded bridge, the argument being that 30 lbs. would turn the train over anyway and wreck the bridge, and, therefore, it may as well be wrecked by the train at 30 lbs. as by the wind, and so it is useless to waste money on 56 lbs. wind bracing, except for the unloaded conditions. There is a tendency to argue things to be impossible, because they are not practicable with the appliances of to-day, and the tendency is to be guarded against.

At the same time, while it is ever necessary to guard against an undue conservatism, it must not, we think, be overlooked that the majority of the swindles which are foisted upon the public by wily charlatans base their claims for recognition on their having completely demonstrated existing ideas to be wrong. There are some facts which we are at liberty to take as fixed, such facts as the possible generation of heat from 1 lb. of carbon. Nor should we feel uncomfortable at the charge of old fossilism if someone showed unduly high evaporation. It is, however, in just such matters that as a nation Englishmen have been a little short, and it is in the knowledge to pick out the reasonable from the unreasonable that the Germans have given us the go-bye in some respects, and that we have urged that our own leading men should be better armed.

Theoretical science is very well so far as it goes. Experimental science is very well if it goes far enough. In the matter of wind pressures alluded to, experimeot has not always gone far enough. We have used a square foot reading as good enough to generalise a whole bridge.

Probably continued experiment would enable some sort of a curve of areas and maximum wind pressures to be worked out so that large structures could at once be safe and economical. The same arguments and facts can be paralleled in many directions. Successful engineering implies correct judgment in estimating reasonable truths.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, BRISTOL, 1898.

THE ACTION OF ELECTRICITY ON PLANTS.

By E. H. COOK, D.Sc., F.I.C.

Abstract of Paper read before Section A.

THE destructive effects of electricity of high potential upon plants needs no demonstration. It is only necessary to remember the wrecks which are made of our finest forest trees by a single flash of lightning to call vividly to mind the enormous power of the discharge. But the action of smaller quantities at lower potentials has not been extensively studied. True it is that from time to time we hear of wonderful results being obtained, and marvellous experiments being made. In many of these cases, undoubtedly, exaggeration has been indulged in, and the attitude of the scientific man has become very much that of the sceptic. This is unfortunate, because there is undoubtedly something in the subject, although the unravelling of the facts is surrounded by peculiar difficulties, involving complicated and extremely prolonged experimentation.

For some considerable time the idea that electricity might have some influence on the growth of plants seems to have been simmering in the minds of many experimenters. Thus, in 1806, the great botanist, de Candolle, experimented for a long time, but without arriving at definite results. Other experimenters also tried, but no results seem to have been obtained until Naudin used means for supplying electricity from an external source to the soil in which the plants were growing. He claims to have obtained increased effects. The experiments of Sir William Siemens with the electric light are well known, but some of the most important have been made in Russia by M. Spechnew, and in France by several agriculturists, of whom, perhaps, M. Barrat and M. Paulin may be mentioned. In these cases the experiments have been made on the large scale, and have extended over many years.

The experiments recorded in this paper were commenced so far back as 1886. They have been repeated many times as the conditions affecting the results gradually became known. They may be considered under three heads:—(1) Those relating to the germination of seeds. (2) Those relating to the growing of plants in soil. (3) Those dealing with the lower forms of plant life such as algæ, fungi, &c.

1. *Influence on the Germination of Seeds.*—Numerous experiments were made in order to see if any effects could be obtained with constant or intermittent currents and with high or low tension electricity. Taking one mode of experimenting as a type of the whole, a current of electricity varying from 1 to 10 milliamperes was passed by means of carbon plates through moistened grains either of barley, wheat, peas, or other seeds contained in beakers. Side by side with these were placed similar seeds through which no current was passed. The current was switched on for about two hours daily. The results were sometimes indefinite, sometimes extraordinarily successful, but the general effect was to give an increased development in the electric seeds amounting to from 10 to 20 per cent. more than in the non-electrified ones.

Experiments were also made with a view of discovering whether constant or intermittent currents were best suited to accelerate the growth. It was found that no advantage could be obtained by constant currents over intermittent ones, and in some cases the constant current was not beneficial.

High tension electricity was tried by subjecting the seeds to electrification from a Wimshurst machine inside glass vessels before planting. The results obtained showed that in this way a *larger proportion of seeds germinated*, but the electrified show no increased growth over the non-electrified.

2. *Influence on Growing Plants.*—The experiments on seeds showed that with a suitable amount of electricity at a suitable E.M.F. the germination was accelerated; it then became necessary to determine whether, after the plant was formed, any increase in the rate of the processes of assimilation and absorption took place. For this purpose experiments were tried with seeds planted in similar soil and in similar pots. Through some of these a current was sent between carbon electrodes, while the others were allowed to grow in an ordinary manner. Experiments were tried with intermittent and continuous currents, and with a variety of seeds. In almost every case the electrically urged plants came to maturity first, but they were also the first to show above the soil, and I could not satisfy myself that, with the currents employed, viz., from 1 to 30 milliamperes and with an E.M.F. of 5 to 25 volts, that any increased rate of growth was observable after the cotyledons appeared above the soil. In other words, an electrically urged plant grown from seed in soil will show above the soil, say, four days before one not so urged; but after that the electrically urged plant will maintain its four days' start throughout—it will not gain after the first start. Therefore, practically, in growing plants in this way, no advantage is obtained by continuing the application of the electricity after the first appearance of the green leaves. This, of course, applies to electricity of low E.M.F.

Experiments were now tried to find if the same peculiarity held for electricity of high E.M.F. For this purpose the discharges from the Wimshurst and from the induction coil were employed. Moreover, the effects of the positive and negative were tried separately. The results showed that with the machine a much increased rate of growth is obtained when the E.M.F. varies from 25 to 40,000 volts; moreover, that the positive always produced the greater effect *at first*, but that the negative rapidly caught up and took the lead. It was also noticed that with this kind of electricity certain kinds of plants, such as bulbs, could be accelerated which could not be influenced by the current. In one of these experiments on hyacinths, the colour of the blossom produced under the negative was distinctly different to that of the positive, as well as to that of the non-electrified. Possibly this may be caused by the larger amount of ozone produced by the negative discharge.

In order to compare the effects of the battery, the induction coil, and the machine, experiments were made with the same seeds grown, (1) without any electricity, (2) with a current passing between carbon electrodes, (3) under the positive point from a Wimshurst machine, (4) under the negative from the same, (5) under the positive point of an induction coil, and (6) under the negative point of an induction coil. *In every case the positive end of the coil produced the greatest effect.* This was with an E.M.F. of approximately 45,000 volts.

Experiments with Low Forms of Plant Life.—Experiments have been made with yeast, spirogyra, and other large celled fresh water algæ.

With yeast the rate of development was measured by the rate of evolution of the carbon dioxide. With this substance (yeast), only the current from the battery has been tried as yet. The results were somewhat indefinite, but an increased effect was produced within a very limited range of E.M.F. and quantity. The complete conditions regulating the growth have not been fully studied but are still under examination.

The effect upon spirogyra was tried with the current, and with positive and negative spraying from the coil and machine. Microscopic examination was continually made in order to see if any alteration could be observed in the end cell of the filament, and also if the process of conjugation was hastened. No definite conclusions could be reached in reference to either. In some instances it was thought that accelerated growth was produced, but repetition of the experiments failed to confirm the results.

In the case of the current, electrolytic effects took place, gases being evolved from the platinum electrodes.

Great care had to be taken in the spraying with the electricity from the machine, because the fibres of the plants were found to be readily broken up at the junction of the cells, and it was difficult when this occurred to judge of the change in growth of the fibres. It is intended to continue these experiments.

Application on the Large Scale.—Experiments have been made by M. Barratt and M. Spechnew by connecting large plates of copper and zinc sunk in the soil with a wire, and growing plants between, and also by connecting plates to a battery. It is, however, evident that if atmospheric electricity could be employed, a practically unlimited source is available. Beckeinstener was the first to try this.

Following him, several experimenters in France and other countries have invented, perfected, and used what has been called the "Géomagnétifère," with remarkable results. The instrument is practically a lightning conductor set up in the middle of a field, and connected below with a series of cross wires running under the soil near the roots of the plants.

The results obtained with this instrument are remarkable. Thus to quote two well-authenticated experiments:—A "Geo." was set up in a field adjoining the main road from Montbrison to Montroud, of 8·5 metres high, and made its influence felt over a circular area of 20 metres radius. Within this area was marked out two squares of 4 metres side, and the potatoes growing in these patches were compared with those growing in two equal-sized patches in another portion of the same field. The potatoes grown in the two squares within the area weighed 90 kilos; those grown outside weighed 61 kilos. The number of plants were practically equal. Again, in another case, 60 potato plants grown near the wires of a "Geo." gave 63 kilos, 100 grammes of tubers, whereas 60 plants grown in the same field, but away from the "Geo.," gave only 35 kilos. This gives a difference in the money value of about £8 16s. per acre. Both these experiments are well authenticated. In view of these results it was determined to make a trial in Clifton. Accordingly, in the early spring, M. Pinot de Moira, who is an excellent amateur gardener, as well as a scientist, was induced to put up a "Geo." in his garden on Clifton Hill. Potatoes, beans, tomatoes, peas, &c., were grown near the wires and in other parts of the garden. A distinctly increased effect was observed in all cases near the wire, thus confirming in some measure the results of the French experimenters. The crop of tomatoes is remarkable; on some plants the number of fruits is between 90 and 100, all well developed. For plants growing in the open air this is remarkable. Unfortunately, it was impracticable to grow unelectrified tomato plants to compare with these under similar conditions. It is, however, much to be desired that further and continuous experiments should be carried out.

Theories to Account for the Action.—Before attempting any theorising, it was thought advisable to thoroughly establish the facts. Much time has, therefore, not been given to the testing of supposed explanations. One of the first ideas would be, that the rise in temperature would, perhaps, cause the effect. Very delicate thermometers plunged in the soil showed no rise in temperature; moreover, it can be calculated that, with the strongest currents employed, the rise in temperature would not exceed $\frac{1}{500}$th of a degree per hour, an amount too small to produce the effects noted.

Another theory which has been proposed by Spechnew is, that a process somewhat like electrolysis goes on in the soil whereby the nutrient material is broken up into compounds which are more readily absorbed by the roots of the plants. In support of this, he cites several experiments which he has made. In confirmation in experiments made to test this, I found in the neighbourhood of the positive electrode the earth was slightly acid, whereas that near the negative was faintly alkaline, thus proving the existence of an electrolytic action. But obviously this explanation will not account for many of the effects, and, in fact, the subject is so wide, that many different actions are probably at work, and it will be necessary to multiply the experiments, and to know more of the conditions, before satisfactory explanations can be given. As a step in this direction, the experiments recorded in this paper are considered to show that a particular plant requires for its maximum development a distinct strength of current and of a definite potential.

THE DROP OF POTENTIAL AT THE CARBONS OF THE ELECTRIC ARC.

By Mrs. Ayrton.

Abstract of Paper read in Section A.

The carbons employed were of the same kind as those used for all my previous experiments on the arc, namely, solid "Apostle" carbons, the positive 11 mm. and the negative 9 mm. in diameter. In order to eliminate errors caused by the difference in hardness or construction of the carbons, only those were used with which it was found that the P.D. between the carbons was within half a volt of that given by the equation which I published in 1895 connecting that P.D. with the length of the arc and the current flowing.

To find the fall of potential between each of the carbons and the arc a third carbon was used, varying in diameter between 0·5 mm. and 2 mm. This was brought up to the crater of the positive or the white hot spot on the negative carbon, and the P.D. between it and the main carbon was observed *just before* it touched the main carbon. The P.D. was measured by means of a high-resistance d'Arsonval galvanometer having a resistance of a million and a half ohms in circuit.

Experiments were made with arcs of 1, 2, 3, 4, 5, 6 and 7 mm., and with currents of 4, 5, 6, 7, 8, 9, 10, 12 and 14 amperes.

The drop of potential at the *positive* carbon I find is affected both by the length of the arc and the value of the current, and the connection between this P.D. in volts, the current in amperes and the length of the arc in millimetres may be expressed by the equation:—

$$v = 31{\cdot}28 + \frac{9 + 3{\cdot}1\,l}{A} \qquad (1)$$

The drop of potential between the arc and the *negative* carbon, on the other hand, is, I find, affected by the *current* only, and *not* by the length of the arc. The equation expressing its connection with the current is—

$$v = 7{\cdot}6 + \frac{13{\cdot}6}{A} \qquad (2)$$

Thus this drop of potential at the *negative* carbon is by no means insignificant, nor have I ever found its sign to change, either with silent or with hissing arcs, as it is said to do by some observers. In all my experiments this drop of potential has been from arc to carbon, and its value has been about one-fourth of the value of the corresponding fall of potential at the positive carbon.

From equations (1) and (2) we can find the equation for the drop of potential at the positive carbon plus the drop of potential at the negative carbon; *i.e.*, the whole fall of potential from carbon to carbon minus the fall of potential through the arc itself. It is

$$v = 38{\cdot}88 + \frac{22{\cdot}6 + 3{\cdot}1\,l}{A} \qquad (3)$$

Now the equation I found three years ago for the *total* P.D. between the main carbons, which included, of course, the drop of P.D. in the arc itself, was

$$v = 38{\cdot}88 + 2{\cdot}07\,l + \frac{11{\cdot}66 + 10{\cdot}54\,l}{A} \qquad (4)$$

The coincidence between the first terms of equations (3) and (4) shows that this constant quantity has at last been tracked home, and that it belongs *not* to the positive carbon alone, as has hitherto been supposed, but to *both* the positive and negative carbons in the proportions of about four-fifths to the former and one-fifth to the latter.

It must be remembered that the experiments upon which equation (3) is based were made nearly two years after those from which equation (4) was obtained, and that for the new equation (3) itself the experiments consisted of two entirely separate sets; the one made to find the drop of potential at the positive carbon and the other to find the drop of potential at the negative carbon.

As regards the accuracy with which equations (1), (2), and (3) express the results of the experiments, it may be mentioned that each of the 124 values from which these equations for the fall of potential at the carbons alone were formed was the mean of the results of from six to 12 experiments. Of these 124 values 96 differed by less than 1 volt from the numbers calculated from the equations, 25 differed by between 1 and 2 volts, and only three differed by more than 2 volts, and these three all belonged to equation (1).

This closeness of agreement between the observed and calculated values is the result of no series of ingenious guesses, but of the algebraical expression of three very simple straight line laws which, I find, exist between the power expended at each of the carbons, the current flowing, and the length of the arc. These three laws may be most simply expressed thus:—

If w be the power in watts expended at either of the carbons (measured by multiplying the current by the fall of potential at the carbon) and a, b, c, d, e, and f be constants, then

For the positive carbon $\begin{cases} w = a + b\,A \text{ with a constant length of arc,} \\ w = c + d\,l \quad \text{,,} \quad \text{,,} \quad \text{current.} \end{cases}$

For the negative carbon $w = e + f\,A$.

A combination of the two first laws gives equation (1), and the third gives equation (2).

The method employed for finding the above falls of potential at each of the carbons was not original. It was first used by Lecher 10 years ago, and has since been employed by Uppenborn, by Prof. Silvanus Thompson, and by many others. These, however, all used a third carbon placed in a stationary position in the arc, while I considered that more accurate results could be obtained by bringing the point of the third carbon up to touch the hottest part of the main carbon, and observing the last P.D. registered by the voltmeter before it fell to zero. Very accurate and definite results were obtained in this way compared with any I could get by the ordinary method, but in interpreting these results it is necessary to take into account the disadvantages under which *all* experiments made with a bare carbon dipping into the arc labour.

1. The third carbon may not take up the exact potential of the part of the arc in which it is placed.

2. If it does, it will bring all the parts of the arc that it touches to practically one potential, which will be greater than the least, and less than the greatest of the potentials that existed in that portion of the arc before it was occupied by the exploring carbon.

3. It repels the arc, and, therefore, makes its real length greater than its apparent length. Hence the insertion of the exploring carbon usually increases the P.D. between the main carbons by from a half to two volts.

As regards the first disadvantage, it is, of course, possible that there is a contact P.D. between the carbon vapour and the solid exploring carbon, but, even if it exists, this P.D. is probably small compared with the P.D.'s with which we are dealing, and I have, therefore, neglected it in the calculation of the equations.

The second point appears to be much more important, for it is quite possible that the variable part of the fall of potential at each of the carbons, given by equations (1) and (2), may be mainly produced by the exploring carbon being in communication with the arc, not only at its tip, but also along a part of its length. For whether the fall of potential at the carbon itself be a constant or not, it is quite certain that the potentials of the other points at which the arc touched the exploring carbon varied both with the current that was flowing and with the length of the arc, before that carbon was inserted. Hence at least a portion of the variation in the values given by equations (1) and (2) must have been created by the use of a bare carbon in the arc, and it is at least *possible* that the whole of those variations were created in the same way.

Many attempts have been made to explore the arc with insulated conductors, notably by Uppenborn, who tried wires embedded in clay, steatite and glass tubes, and had to abandon them all. I myself have tried asbestos coverings for the carbons, but the asbestos melted and fell in drops like metal. Now that the importance of insulating the exploring carbon is so very apparent, however, it will be worth while making a very great effort to find some insulating material that will stand the heat of the arc, and will yet not have to be so thick

as to disturb it unduly. This I hope very shortly to do, and thus to completely solve the question of the constancy of the drop of potential at the carbons of the arc.

THE USE OF ELECTRIC BALLOON SIGNALLING IN ARCTIC AND ANTARCTIC EXPEDITIONS.

By Eric Bruce.

Read before the Geographical Section.

The author said the absence of means of intercommunication was one of the most distressing deprivations which befel the Arctic and Antarctic explorer. In Dr. Nansen's recent expedition, the want of some bond of communication between the drifting ship and a party leaving the vessel for only short excursions was severely felt, and greatly restricted the researches of the expedition. A means of communication could be afforded by the system of electric balloon signalling invented by the author, adopted for war signalling purposes by the British, Belgian, and Italian Governments, and lately adapted to the wants of Arctic and Antarctic exploration. Signalling with flag or lantern from the car of an ordinary captive balloon, worked from the deck of a ship, was possible, but such a method necessitated a large balloon, with its cumbersome accessories, and was therefore impracticable in Arctic expeditions. In electric balloon signalling, the signaller and most of the apparatus remained on the ground or deck of the ship. Since the weight of the car, signaller, and apparatus was abolished, the balloon could be of such a moderate size as to be practical. The apparatus consisted of a balloon made of a translucent material and filled with hydrogen or coal gas. In the balloon were placed several incandescent electric lamps in metallic circuit with a source of electricity on the ground or deck of the ship. In the circuit on the deck was an apparatus for making and breaking contact rapidly. By varying the duration of the flashes of light in the balloon, it was possible to signal according to the Morse code. In the signalling key there were carbon contacts, renewable when worn away by sparking. The key was placed on a switchboard, which was provided with a means of turning the current on to the lamps in the balloon, either through the key or directly for continuous illumination. The speed of signalling depended entirely upon the thickness of the carbon filaments in the lamps. The material selected for making electric balloons that were designed for Arctic work was goldbeaters' skin, which was light, strong, and retentive of hydrogen. The smallest size goldbeaters' skin balloon that would lift the lamps and a sufficient quantity of cable to be useful was 7 feet in diameter, having a capacity of 150 cubic feet. It took little over one tube to fill it. The electric incandescent lamps inside the balloon were supported one above the other on a holder made like a ladder. That form of ladder was convenient for admission into the narrow neck of the balloon. The electric cable combined lightness, flexibility, and current capacity, being made of strands of copper, both leads being enclosed in one waterproofed outer insulation. The source of electric power for lighting the lamps in the balloon would probably be the dynamo, with which every future exploring vessel would probably be provided, and which could be efficiently worked with wind or hand-power. If a balloon and accessories were taken from the ship by an excursion party, light and portable storage cells could be used. The gas for filling the balloons could be compressed in steel cylinders, or a portable apparatus could be used for making the hydrogen on the pot. This system of signalling made the signallers fairly independent of the configuration of the country. An electric balloon ascending from the deck of the exploring vessel would not only act as a beacon guide to exploring parties, but would flash signals relating to the drift of the ship or any other desirable communication. If an exploring party could take another balloon with them, complete intercourse could be established. If the *Fram* had had an electric balloon afloat, it would have been probably seen by Dr. Nansen when he was returning from his journey North, and possibly a long and perilous march might have been avoided. An electric balloon would have been an important addition to an Arctic station such as Elmwood. The electric balloon had been successfully manipulated, not only in calm and fair weather, but in half a gale, a snowstorm and mist; signals had been read and answered in spite of these adverse atmospherical conditions. Arctic records, however, included a large proportion of still and clear weather. Continuously illuminated, and sent up a short distance from the ship, the balloon would also be serviceable as a light for working parties, because of the diffusion of light from the large surface. Regarding the distance to which signals might be transmitted, it was reasonable to expect that, given a sufficient altitude, a high candle-power, and a clear atmosphere, through a telescope the flashes would be visible some 80 or even 100 miles.

Mr. Douglas Archibald, who had used kites for meteorological observations since 1884, said there were grounds for believing that kites would support a considerable weight, and transfer it from one place to another, gliding down gradually. But he thought the kite in conjunction with the captive balloon the better idea. Kites could be used for taking photographs of a country, and he believed they were destined to be used very much in future wars.

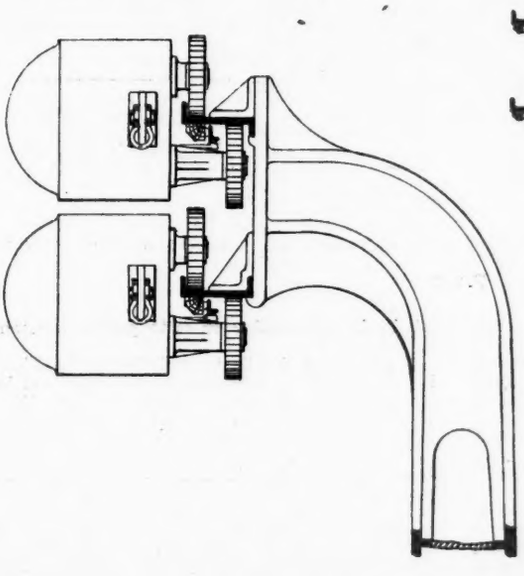


Fig. 2

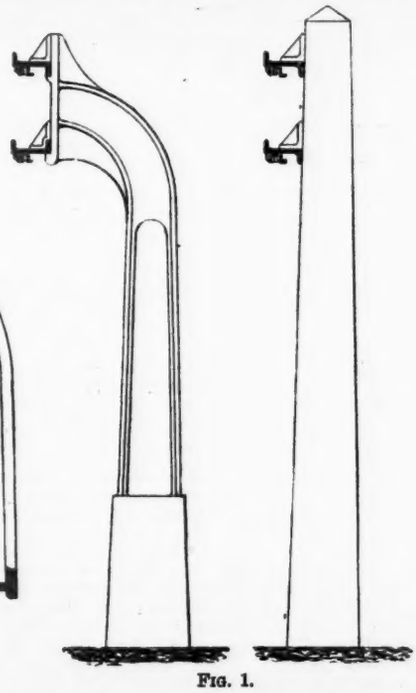


Fig. 1.

ELECTRIC CANAL HAULAGE.

By A. H. Allen, A.Inst.E.E.

Read in Section G.

In the days before the advent of the locomotive engine, by far the greater part of the goods traffic in the interior of this country was carried on by means of canals, of which about 4,000 miles are in existence, representing an immense amount of capital. In the year 1825, when the prosperity of the canal traffic was at its highest, the Birmingham canal yielded a revenue of cent. per cent., and one of the Manchester canals paid in dividends every second year a sum equal to the total original outlay!

With the development of railways, however, our once splendid canals—the heritage of the 18th century—rapidly fell into comparative disuse, and at the present day the traffic upon them forms but a small proportion of the whole inland trade of this country, a woeful contrast with the prosperous canal system of Germany, France, and Belgium, and far from creditable to ourselves.

It would be interesting, if time allowed, to inquire into the causes which have brought about this decay of a vast system of communication, and reduced it to its present state; but to be brief, the fundamental factors are the slow speed of transmission as compared with that of railways and coasting steamers, and the heavy charges for tolls and for towing. The very fact that the traffic has decreased has reacted upon the tolls, for it is found that the cost of maintenance of canals is practically constant, irrespective of the amount of traffic, so that as the traffic diminishes, the tolls must be increased. Hence, if by increasing the speed and reducing the cost of towing, a larger traffic can be attracted, the tolls will be reduced also.

The method of haulage in general use remains the same as it was

a century ago—by horses. Steam tug boats have, it is true, been adopted here and there, but their use is limited by many considerations, such as the cost of the boats, the damage done to the banks of the canal by the scouring action of the propellers, and the very low efficiency on account of the small cross section of the canal, while the cost of haulage is but little less than that of horse traction.

The subject of this paper is an adaptation of electrical traction to canal haulage, with a view to accelerating the speed and at the same time reducing the cost—the two most important considerations in connection with goods traffic. The system to be described is the outcome of years of study on the part of Messrs. Thwaite & Cawley, civil engineers, of Westminster; the aim of the inventors has been to provide an economical and efficient method of haulage, which can be applied to any canal, without in the least interfering with the use of horses—thus enabling the latter to be displaced by degrees, if desired. The system is about to be tested on one of the great Northern canals. It has been submitted to the critical examination of our most eminent canal experts, and it is admitted that it shows promise of satisfying the numerous and difficult conditions of canal traction.

Previous attempts towards applying electric traction have generally been in the direction of supplying electrical energy, by means of overhead wires along the banks, to electromotors carried on board the barges; the motors were usually geared to screw propellers (as, for instance, on the Erie Canal), in one case to an aerial propeller. None of these methods has attained any degree of success—chiefly on account of the same difficulties as lie in the way of steam propulsion. A length of three miles on the Burgundy Canal is operated electrically by means of a chain laid along the bed of the canal; a tug boat fitted with an electromotor and chain barrel works to and fro on the chain, hauling a train of barges. The current is received from an overhead wire, and returns *viâ* the chain and earth. The system is well adapted for the case in question, as two out of the three miles are through tunnels; but the great loss of time incurred when one train passes another is a fatal bar to its general adoption.

In the present system all these difficulties are avoided by making the motors entirely independent of the barges, and hauling the latter by means of ropes, exactly as with horses; in this way the waste of energy incurred with a screw propeller is almost entirely obviated. An aerial railway is provided, consisting of two steel rails of channel or Z section, braced together *at one side*, so as to form a rigid girder, and supported at a height of 9 or 10 feet * above the towing path by means of cast-iron brackets or wooden posts (fig. 1), at intervals of about 30 feet. Each of these rails constitutes a running track for a number of electric locomotives, each consisting simply of an electromotor mounted on a four-wheeled carriage; two of the wheels run upon the upper surface of the rail, supporting the weight of the locomotive, and two run beneath the rail, bearing against the lower surface in such a way as to ensure the stability of the locomotive (fig. 2). Two horizontal rollers are pressed by springs against the edge of the rail, in order to guide the carriage in the correct running position. The locomotive is thus locked to the rail, and is securely held in position by its own weight; moreover, by giving suitable proportions to the relative lengths of the axles of the wheels, the total pressure between the wheels and the rail can be made as great as may be desired—far greater than the weight of the locomotive itself—so that there is no limit to the adhesion which can be obtained between the wheels and rail. As the maximum drawbar pull of a railway locomotive under ordinary conditions is only about one-seventh of its weight, this is an important feature of the system.

The motor shaft carries at each end a worm, gearing with a worm-wheel on each of the four axles, so that *all* the wheels are drivers (fig. 3); the gearing runs in an oil bath, and can be so designed, as to give an efficiency of 90 per cent. Automatic lubrication is provided for all the working parts, so that frequent inspection is not necessary.

The motor itself is of the ordinary direct current series-wound traction type, and need not be described in detail. The tractive force required to tow a barge carrying 100 tons on a canal of ordinary cross-section, at the rate of 2½ miles per hour, is from 250 to 300 lbs. The maximum brake horse-power at full speed is, therefore:—

$$= \frac{2{\cdot}5 \times 5{,}280 \times 300}{60 \times 33{,}000} = 2 \text{ B.H.P.}$$

But in order to get up speed quickly at starting, the motor must be designed to give a tractive force of about 600 lbs. for a short time. Such a motor would weigh about 300 lbs., and the weight of the motor and carriage would not exceed 900 lbs.

For a speed of four miles per hour, under the same conditions, the motor should give a tractive force of 750 lbs. at full speed, and, say, 1,200 lbs. at starting. The weight of the motor would in this case be about 600 lbs., and of the motor and carriage about 1,400 lbs.

To the lower side of each rail is bolted a continuous creosoted wood batten, which supports the electrical conductor, a flat copper or steel angle bar, insulated from the wood by means of porcelain insulators. The position of the conductor is such that it is shielded from the weather, and to a great extent from mechanical injury.

The current is collected from the conductor by means of an insulated brush attached to the locomotive, and after passing through the motor is conducted by the wheels to the rails, which are electrically bonded together so as to provide a return path of low resistance.

It will be seen that the two rails form an "up" line and a "down" line, so that the locomotives run on the upper rail in one direction, and on the lower rail in the opposite direction. Each locomotive is provided with a link to which the tow-rope is attached, the other end of the tow-rope being secured to the mast of the barge exactly as in the case of horse haulage. When two barges meet, that one which is being towed by the lower locomotive steers close to the towing path, while the other barge steers wide, so that the towrope of the second barge passes clear over the first; thus there is no possibility of entanglement or crossing of the ropes, and the locomotives and barges pass freely without necessitating a stoppage. The importance of this point will be realised if it is borne in mind that on the average three minutes are lost every time two barges pass when drawn by horses, or about one-fifth of the whole time occupied in making a journey on a busy canal.

The locomotive is controlled entirely from the barge, no driver being required. Various methods of control are available; two light cords may be used, leading from the barge to a switch mounted on the motor carriage; or a single cord may be employed, together with a switch so constructed that on pulling the cord the switch is closed, the next pull opens the switch, and so on alternately. Another method of control is by the use of a concentric or twin-wire cable for the towrope; in this case the starting switch may be placed in the barge itself, in the charge of the barge-master, or the switch may be carried in the locomotive and controlled by electrical means from the barge. It should be remembered that, even when starting up to a speed of four miles an hour, the current at 500 volts would not exceed 14 or 15 amperes, so that elaborate switching apparatus is not necessary.

Since the whole apparatus is entirely separate from the barges, and complete in itself, it is evident that *any barge or boat whatever* may be towed without requiring the slightest alteration. On arrival at

Comparison of Cost and Time Occupied in Working by Horses and Electricity at 2½ and 4 Miles an Hour.

E, Electrical; H, H

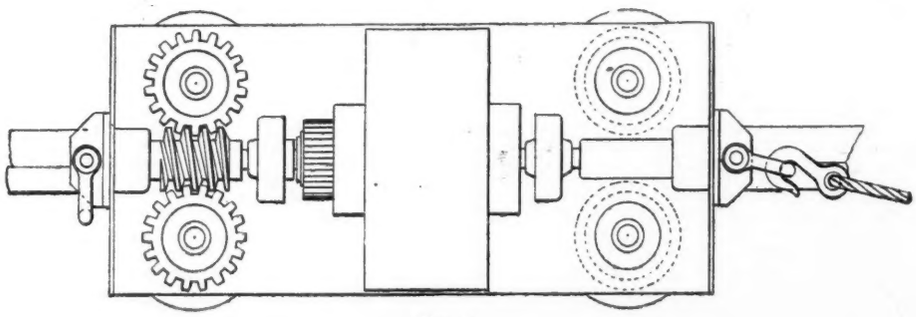


Fig. 3.

* Where horses are not used, the rails may, with advantage, be fixed at a height not exceeding 6 feet from the ground, so that the locomotives may be more readily accessible.

the end of the journey the locomotive may be at once coupled to another barge, leaving the first to be unloaded or otherwise at leisure; hence the plant can be kept continuously at work at its maximum earning capacity, and the ratio of the expenditure to the receipts can be kept down, both on this account, and because a given number of locomotives can serve the needs of a much greater number of barges.

Electrical power is supplied from one or more generating stations situated at suitable points on or near the canal; it is important to notice that water-power may be used if such be available, or the generating plant may with great advantage be erected at a colliery if the canal passes through a coal field, so as to obtain coal at the lowest possible rates. The canal itself supplies water for condensing purposes if steam-power is used, but it is preferable to employ gas engines, by means of which, in conjunction with the Thwaite system of gas producers, it has been proved to be possible to generate 1 indicated horse-power-hour with an expenditure of less than 1 lb. of coal.

In the case of long canals, the power would be transmitted on the three-phase alternating current system at high pressure, transforming down to direct current at low pressure at convenient points on the line, as shown in fig. 4; for short canals the current would be supplied direct to the line.

A very important feature of the system is the fact that not only will power be available for hauling barges, but it may also be used for working cranes, factory machinery, lock-gates, &c., and for lighting warehouses and the canal itself if desired; a useful application of power is to capstans at the locks, by means of which the barges can be handled with rapidity and ease when entering the locks or leaving them. As canal traffic with electrical haulage can be carried on both by night and by day, the conditions of working are specially favourable to a low cost of power, the generating and distributing plant being constantly in use with no idle period.

In order to illustrate the economic possibilities of the system, estimates have been prepared showing the cost of haulage, (1) by horses; (2) by electric locomotives, at the same running speed as with horses; and (3) by electric locomotives at a higher speed (4 miles per hour). For the purpose of this comparison, the case of a level canal, 30 miles in length, has been taken, with an annual traffic of 100,000 tons per mile. The details of the estimates are given in an Appendix to this paper. The results in brief are as follows:—

	Cost per ton mile.	Time occupied in transit.
Haulage with horses, at 2½ miles per hour	0·077d.	15 hours
Electric haulage, at 2½ miles per hour	0·032d.	12 „
Electric haulage, at 4 miles per hour	0·041d.	7½ „

It will be seen that without taking advantage of the higher speed possible with electric haulage, the cost is 58·4 per cent., and the time 20 per cent. less than with horses, while when the speed is increased to 4 miles per hour, the cost is 47 per cent., and the time 50 per cent. less than with horses.* Further, in the latter case, no allowance has been made for the reduction in the capital cost of barges (of which a smaller number would suffice), in the interest and depreciation on capital, and in the wages paid to bargemen, nor for the increase in the traffic and reduction of tolls which are sure to follow the increase in speed, the sale of electrical energy, the great reduction in cost of maintenance during prolonged frosts, &c., all of which are items of the first importance in this connection.

To sum up, then, the electrical system of haulage possesses the following advantages, among others:—

The boats require no alteration whatever.

The delays in passing incurred with horse haulage are obviated.

Bridges and tunnels cause neither difficulty nor delay.

No time is lost in waiting for a train of barges to be loaded, as is the case with steam.

Power can be supplied to private consumers, &c., at a low rate.

The cost of haulage is reduced by 50 or 60 per cent., and the time occupied in transit by 20 to 50 per cent., as compared with horse haulage.

In case of frost, the standing expenses are enormously less than with horses.

* On some of our most important systems the dimensions of the canal and of the locks will only permit the passage of barges carrying 50 tons of cargo. In this case the saving in cost is *increased* to nearly 65 per cent. at 2½ miles per hour, and to 60 per cent. at 4 miles per hour, the same traffic being taken; but the cost of horse haulage is doubled, and that of electric haulage is also increased, though to a less extent.

APPENDIX.

Basis of calculations:—Canal 30 miles in length, daily traffic 10,000 tons; 100 barges, each carrying 100 tons, and completing one journey per diem on 300 days per annum. 80 per cent. through traffic, 20 per cent. distributed; therefore average lead 27 miles.

CASE I.—Cost of haulage by horses; each barge is towed by one horse in 10 mile stages, one stage being a day's work for a horse.

CAPITAL COST.

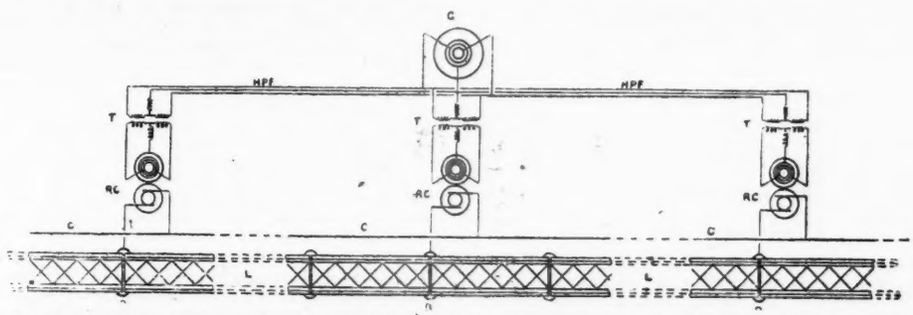
300 horses at £40	£12,000
300 sets harness at £10	3,000
300 stalls at various points on the line of route, at £30	9,000
	£24,000

ANNUAL EXPENDITURE.

Interest on £24,000 at 5 per cent.	£1,200
Depreciation on £12,000 at 20 per cent.	2,400
„ £3,000 at 15 per cent.	450
„ £9,000 at 5 per cent.	450
Maintenance of horses at 18s. per horse per week ...	14,040
Wages of 150 drivers at £50 per annum	7,500
	£26,040

$$\text{Cost per ton-mile} = \frac{26{,}040 \times 240}{300 \times 10{,}000 \times 27} = 0{\cdot}077\text{d.}$$

$$\text{Time occupied in transit} = \frac{30}{2\frac{1}{2}} + 3 = 15 \text{ hours.}$$



B, Bonds; C, Working conductor; G, Three-phase alternate current generator; H P F, High pressure feeders; L, Aerial railway line; R C, Rotary converters; T, Stationary transformers.

FIG. 4.—INDEX TO PARTS.

CASE II.—Cost of electric haulage at 2½ miles per hour; each barge is towed by one locomotive, making one journey per day.

CAPITAL COST.

Aerial railway, 30 miles at £1,800 per mile		£54,000
Electrical plant	£4,500	
Gas engines and producers	4,000	
Distributing mains	5,000	
Switchboards, &c.	500	
		14,000
Generating station and sub-stations		2,000
Locomotives, 100 at £75		7,500
		£77,500

ANNUAL EXPENDITURE.

Interest on £77,500 at 5 per cent.	£3,875
Depreciation on £54 000 at 5 per cent.	2,700
„ „ £7,500 at 15 per cent.	1,125
„ „ £14,000 at 8 per cent.	1,120
„ „ £2,000 at 4 per cent.	80
Coal, 2 000 tons at 10s. per ton	1,000
Wages of eight men at £75 (average)	600
Management	200
Oil, waste, stores	200
	£10,700

$$\text{Cost per ton-mile} = \frac{10{,}700 \times 240}{300 \times 10{,}000 \times 27} = 0{\cdot}032\text{d.}$$

$$\text{Time occupied in transit} = \frac{30}{2\frac{1}{2}} = 12 \text{ hours.}$$

Case III.—Cost of electric haulage at four miles per hour; each barge is towed by one locomotive, which makes two journeys per day.

Capital Cost.

Aerial railway, 30 miles at £2,400 per mile		£72,000
Electrical plant	£6,000	
Gas engines and producers	5,500	
Distributing mains...	7,000	
Switchboards, &c.	600	
		19,100
Generating stations and sub-stations		2 500
Locomotives, 50 at £120		6,000
		£99,600

Annual Expenditure.

Interest on £99,600 at 5 per cent.	£4,980
Depreciation on £72,000 at 5 per cent.	3,600
„ 6,000 at 15 „	900
„ 19,100 at 8 „	1,530
„ 2,500 at 4 „	100
Coal, 2,800 tons at 10s. per ton	1,400
Wages, 10 men at £75 average	750
Management	250
Oil, waste, stores	300
	£13,810

$$\text{Cost per ton-mile} = \frac{13{,}810 \times 240}{300 \times 10{,}000 \times 27} = 0{\cdot}041\text{d.}$$

$$\text{Time occupied in transit} = \frac{30}{4} = 7\tfrac{1}{2} \text{ hours.}$$

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1898.

Compiled expressly for this journal by W. P. Thompson & Co, Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, *to whom all inquiries should be addressed.*

19,337. "Electric apparatus for regulating clocks." R. J. Rudd. Dated September 12th.

19,348. "Improvements in the trolleys or contact devices of certain electrically-driven vehicles." A. H. Gibbings and J. Kay. Dated September 12th.

19,381. "Improvements in electric traction." M. Walker. Dated September 12th.

19,396. "Improvements in electrical indicating apparatus." A. U. Alcock. Dated September 12th.

19,399. "Improvements in arc lamps." P. Mersch. Dated September 12th. (*Complete.*)

19,445. "Improvements in electric batteries." H. Blumenberg. Dated September 13th.

19,480. "Improvements in apparatus for controlling and regulating electric currents." J. D. F. Andrews. Dated September 13th.

19,500. "An improvement in connections for electrical fuses." T. McEwan. Dated September 14th.

19,524. "Improvements in or connected with electric clocks, time switches or the like." G. F. Bristow, jun., and W. Jones. Dated September 14th.

19,535. "Improvements in and connected with electric motors partly applicable to dynamos." S. W. Maquay and P. E. Vanderpump. Dated September 14th.

19,536. "Improvements in and connected with primary batteries." S. W. Maquax and P. E. Vanderpump. Dated September 14th.

19,537. "Improvements in dynamo-electric machines." J. Burke. Dated September 14th. (*Complete.*)

19,555. "Improvements in the bulbs of electric incandescent lamps." C. Bartenstein. Dated September 14th.

19,564. "Improvements in or relating to the generation and utilisation of electricity from thermopiles." C. M. Johnson. Dated September 14th.

19,581. "Improvements in the decomposition of alkaline salts by electrolysis and in apparatus therefor." J. Greenwood. Dated September 14th.

19,612. "Improvements in switches for controlling electric motors." F. W. Reed. Dated September 15th.

19,614. "Improvements in electric telegraphs." C. Adams-Randall. Dated September 15th.

19,621. "Improvements in coin-freed electric meters." C. W. S. Crawley. Dated September 15th.

19,632. "Improvements in and relating to secondary batteries." W. A. Crowdus. Dated September 15th.

19,636. "Improvements in or connected with the distribution of electricity on the three-wire direct current system." A. B. Blackburn and W. L. Spence. Dated September 15th.

19,644. "Electric dynamic system of propulsion." W. H. Wheatley. (L. Rosenfeld, C. Zelemay, and J. Dulait, Belgium.) Dated September 15th.

19,688. "Improvements in connection with the mechanism of electrically-illuminated devices for automatically making and breaking electric circuits used in such electrically-illuminated devices." J. S. Richardson, S. Jevons, and W. A. Gent. Dated September 16th. (*Complete.*)

19,722. "Improvements in a 'built in system' of insulated electric conductors." W. R. Macdonald and A. F. Stevenson. Dated September 17th.

19,785. "Improvements in incandescent bodies for incandescent electric lamps, and in the process of manufacturing the same." C. Kellner. Dated September 17th.

19,788. "Improvements in motor driven vehicles and in electric motors therefor." W. A. Crowdus. Dated September 17th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, *price, post free,* 9d. *(in stamps).*

3,645. "Arrangement for transmitting telegraphic messages in contrary directions simultaneously over a single wire." M. Bernstein. Dated February 14th, 1898. At each station along a single wire a similar apparatus is placed. This apparatus consists of two cam discs rotating with isochronal motion mounted on a non-conducting axis. There are friction arms secured to a racking axis, and making contact with the cams, and with a cross bar, so that when the arms are raised by the cams of the discs. The circuit of one of the receivers is broken. In the working of this arrangement two pairs of electro-magnet coils are used, consisting of polarised relays with armatures in equilibrium on their fulcrum when no current is passing; and so causing the various currents from various sounders to operate only at the definite receiving station. 4 claims.

6,032. "Improvements in electrical or electro-magnetic therapeutic apparatus." O. Wacatka and E. Sachs. Dated March 11th, 1898. Relates to a therapeutic apparatus worked by electricity or electro-magnetism. It consists of a strip of copper, covered with a strip of flannel, and the flannel is covered by a strip of zinc. The whole is surrounded by an insulating substance. Subsequently the two ends of the bar thus formed are covered with and connected by copper wire windings. The non-insulated ends or terminals of the conducting wire are constructed in the form of ears or loops by which the therapeutic apparatus is suspended. 3 claims.

8,848. "Improvements in the method of and means for the electrical propulsion of railway, tramway, and other similar vehicles." W. G. Heyes. Dated April 15th, 1898. Relates to the method of and means for the electrical propulsion of railway, and similar vehicles, in which the electric motor drives the axle of the vehicle, the motor is fixed to the framing of the vehicle by feet or lugs. The spindle of the motor armature carries a spur pinion, which engages with a spur wheel fixed upon a hollow shaft concentric with the axle. The shaft is, therefore, constantly parallel with the armature spindle. The axle and wheels are driven from the hollow shaft by means of an elastic connection. 3 claims.

10,523. "Improvements in regulating electric arc lamps." I. H. Hegner. Dated May 7th, 1898. Relates to the regulation of arc lamps working in series. The regulating rheostat is divided into two parts which may be automatically and successively included in or cut out of the circuit as the intensity of the current increases or diminishes. This is to diminish or disperse with the rheostats generally employed; while retaining a compensating action, which can be applied at the moment of the fluctuation of the current, and thereby increasing the out-put of the lamps. 2 claims.

12,019. "Manufacture of active material for accumulator batteries." H. T. Jacob and H. Graeber. Dated May 26th, 1898. Relates to the manufacture of active material, free from non-conducting binding material for accumulators. It is produced by mixing a paste of finely powdered lead oxide and graphite with dilute sulphuric acid, and moulding the mass to the desired form, then alternately drying the material and treating it with dilute sulphuric acid until the mass is hard and coherent, and does not require a supporting frame. 1 claim.

13,721. "Improvements in suspended electroliers." J. G. S. Cunnington. Dated June 20th, 1898. In an electrolier there is a suspended frame work incapable of being moved up and down. In combination with this framework there are pulleys over which each conducting and lamp suspending cords pass. There is a weight to counter-balance each lamp separately. 1 claim.

15,647. "Improvements in electrically ignited fuses for blasting purposes." H. Bettermann. Dated July 16th, 1898. Relates to electric time-fuses for blasting purposes wherein between the real fuse and the detonating cap, a column of slow burning powder or the like is inserted for determining the time taken for the ignition of the cap. The protecting cover made of metal, paper, &c., has in its middle two or more openings which serve for the escape of the gases developed during the burning of the powder column. 2 claims.